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ABSTRACT

This collection of 21 teaching units is designed for use in energy education within various disciplines of the secondary curriculum. Each unit is designed to stand alone. Suggested teaching times range from five to fifteen days. No particular order of presentation is implied. Each unit is organized as follows: abstract, recommended level, time required, teaching strategies, advance preparation, goals and objectives, daily lessons recommended, evaluation suggestions, and bibliography. Units that require handouts or transparencies include duplication masters. Teachers are encouraged to modify the units. Topics include scientific principles of energy; historical, present and future energy sources; economics; and solar energy. (RE)

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nebraska energy conservation plan

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BTU'S
Basic Teaching Units on Energy

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SE 029 327

Basic Teaching Units
BTU's
on Energy

Co-edited by
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Acknowledgements

The Nebraska Energy Office would like to thank the many people who helped make the development of these units possible. First and foremost, Dr. Robert Reeder, Science Department Chairman at Lincoln East High School, whose valuable assistance did a great deal to make the "Energy Institute" a success in 1978. The NEO would also like to thank Mr. Paul Johnson, State Social Studies Consultant, and Mr. Don Woodburn, State Science Consultant, both with the Nebraska Department of Education for their continuing help and suggestions.

We would also like to thank the NEO secretaries, Gail Hackwith, Jan Knight, and Barb Rowen, who spent many hours typing the final manuscript. Most importantly, the NEO would like to thank the teachers themselves, who participated in the energy institute for seeing a need to have energy education at the secondary level.

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Introduction

This publication contains the 21 Basic Teaching Units (BTUs) on Energy to be used by teachers in Nebraska. These instructional units are designed to be used in various sectors of the secondary curriculum, including the natural and social sciences. They also have potential use in the Home Economics, Industrial Arts, and Vocational Agriculture aspects of the secondary curriculum.

The units contained here cover several of the important aspects of the total energy picture. They are designed to stand alone and may be taught at many of the various levels of the secondary curriculum. They range from 5 to 15 days in duration. They are not arranged in any order since it is being left up to the individual teacher to decide which of the units are to be taught in any one classroom.

Each unit, although different in content, has the same basic organizational structure. The format of each unit is as follows: an abstract, the recommended level, the time required, the major teaching strategies, essential advance preparation, the goals and objectives, the daily lessons recommended, evaluation suggestions, a bibliography, and a supplement, if needed. This plan does not in any way impede individual teachers from making some alterations or additions that best suits the needs of their students. For example, the teacher may find some of the suggested activities may cause an expansion of these activities or alternate activities to be developed. This freedom to innovate is encouraged by the NEO. The units that require transparencies or handouts contain this material and all that the teacher has to do is duplicate the material and hand it out to the students. Keys to daily or unit evaluations are also included for the teachers.

The Nebraska Energy Office realizes that teachers who can write instructional units have combined the unique talents of creativity and hardwork. We owe the teachers who collaborated on these units a great deal for the service that they have provided for energy education in Nebraska.

The units were produced at a three-week energy institute which was held at the University of Nebraska's Teachers College. The institute was funded by grants from the United States Department of Energy under their Faculty Development Project in Energy and the Nebraska Energy Office in accordance with P.L. 94-385. Dr. Donald McCurdy, UNL Teachers College, and Gary A. Lay, Education Coordinator for the Nebraska Energy Office, co-directed the institute with assistance from Dr. Robert Reeder, Science Department Chairman of East High School in Lincoln, Nebraska. The plan for the institute calls for piloting this material in Nebraska schools during the 78-79 academic year, revisions will be made and then the material will be available statewide during the 79-80 academic year. Teachers interested in using the BTUs should contact the Nebraska Energy Office for the units.

These units dealing with energy education will be an invaluable tool to the teachers of the State as they teach the adults of tomorrow about the complex issues involved in the energy crisis. The opinions voiced in these units do not necessarily reflect the policy or position of the State of Nebraska, the Nebraska Energy Office, the University of Nebraska-Lincoln, or any other State agency but are the sole responsibility of the authors. Since these units contain laboratory experiments, it is recommended that standard laboratory precautions and equipment be used.

Gary A. Lay
Education Coordinator
Nebraska Energy Office

FUELING AROUND
COULD BE HAZARDOUS
TO YOUR HEALTH

Recommended Level
Grades 7-12

Time Required
Ten Class Periods

by:
Ruth Hahn
Robert Harper

Prepared for
the Nebraska Energy Office

ABSTRACT

There is no way for society to avoid paying for pollution. If we do not pay for prevention, we pay in other ways. If we continue to burn ever-increasing amounts of gasoline in our automobiles, the resulting damage to the air we breathe could be hazardous to our health. This unit proposes to let studnets become actively involved in determining the effect that auto exhaust fumes have on the air they breathe by utilizing laboratory experiences, independent research, and in-class discussions. It is our hope that these exercises will create an awareness of health hazards connected with auto emissions.

RECOMMENDED LEVEL

Grades 9 - 12

TIME REQUIRED

10 days

MAJOR TEACHING STRATEGIES

- class discussions
- individual research
- observation
- audio-visual
- comparison
- skill development
- inquiry

ESSENTIAL ADVANCED PREPARATION

- Common high school laboratory materials
- AV -- overhead projector and 16mm projector
- Some reading of background material from sources listed in the bibliography

GOALS

It is important that students know that automobiles emit substances that endanger air quality.

Students should think about the fact that the automobile contributes the majority of the harmful air pollutants.

Students should realize that the health of Americans is affected by automobile exhaust emissions.

The student should understand that air quality varies with the quantity of pollutants that it carries.

EVALUATION SUGGESTIONS

Daily evaluation by handing in the post labs.

Unit test would be optional

INTRODUCTORY SESSION

TIME: 1 Day

OBJECTIVE: The student will become aware of the problems of air pollution caused by automobiles.

MATERIALS: 16mm projector.

PROCEDURE:

1. General discussion of the problem
2. Show film: Air Pollution: *Take a Deep Deadly Breath*. (Color--54 min.) Available from the UNL film library.

TEACHER FACT SHEET: BURNING DEMONSTRATION

Each time we start a car, we affect our environment in some way. Most of our energy is produced by burning fossil fuel in our internal combustion engines. As a result, millions of tons of pollutants are thrown into our atmosphere each year. The auto is the biggest polluter of all. It, along with trucks, not only pollute the air, but they also contribute indirectly to other forms of pollution. For example, water pollution from oil spills and refinery discharge as well as land disruption from pipelines and oil wells are all a part of the automobile industry.

The automobile has introduced its own characteristic smog called the "photochemical smog". This type of smog first made its appearance in the air-locked Los Angeles basin. By definition, photochemical smog is a chemical soup that sunlight concocts from the hydrocarbons and nitrogen oxides found in automobile exhausts. Its effects on the human body have not yet been fully investigated. However, its potential for irritating eyes and lungs is painfully obvious. As yet, it has not been shown as the direct cause of death.

The auto is also responsible for two other pollutants, carbon monixide and lead. Carbon monoxide is lethal at high concentrations and causes distress at levels of 50 to 100 parts per million. These levels are occasionally reached in auto tunnels and closed buildings. An estimated 420,000 tons of lead were released into the atmosphere in 1972 and this amount has increased yearly. Since lead accumulates in the body, we must watch carefully for long range effects.

BURNING DEMONSTRATION

TIME: 1 DAY

OBJECTIVE: The student will be able to list the products given off into our atmosphere if sufficient heat and air are supplied to burn coal, wood, paper, and leaves.

MATERIALS:

- wood shavings
- coal
- paper
- leaves
- stirring rod
- wire screen
- tripod and ring stand
- ice cubes
- beaker
- limewater
- evaporating dish

PROCEDURE:

*Because most schools do not have an adequate number of hoods, we suggest that this be a demonstration rather than allowing for active participation by students.

1. Weigh each sample of coal, paper, wood shavings, and leaves on a wire screen.
2. Place the wire screen on a tripod or ring stand. Set a burner underneath and burn as much of the material as possible.
3. Test for Water Vapor: (While material is burning)
   a. Place ice cubes in a beaker and hold the beaker above the fumes. If water vapor is present, it should condense on the beaker. For comparative purposes, a beaker with ice should be placed nearby.
4. Carbon Dioxide Test:
   a. Dip a glass stirring rod in the gases above. the flame. Carbon Dioxide will be indicated by the formation of a white precipitate.
5. Carbon and Soot Test:
   a. Place some water in an evaporating dish. (The water in the dish prevents the dish from breaking.) Hold the dish in the smoke. The carbon will collect on the bottom of the evaporating dish.

RESULTS AND CONCLUSIONS:

1. Fill out the chart provided. (It would be advisable to do this as the demonstration proceeds.)
2. Questions:
   a. Which fuel gave off the least smoke? Most?
   b. Which fuel left the least ash? Most?
   c. Would the burning of gasoline in car engines produce atmospheric particles similar to those produced in this demonstration?

BURNING DEMONSTRATION INFORMATION CHART

MATERIAL BURNED	WT. OF MATERIAL	OBSERVATIONS
COAL		
WOOD		
PAPER		
DRY LEAVES		

CALCULATIONS:

TEACHER FACT SHEET: PARTICULATE MATTER IN THE AIR

The burning of fossil fuels in our nation's automobiles have added many other substances to the air besides carbon dioxide and water vapor. Five of them are known to be hazardous or injurious to plants and animals and are of the greatest concern to us.

To introduce this experiment, the teacher might want to spend some time talking about:

(1) Health vs money in controlling air pollution from automobile exhausts.
(2) Drivers and maintenance. Anti-pollution devices will not work if cars are not properly maintained.
(3) Other engines and other energy sources.

PARTICULATE MATTER IN THE AIR

TIME: 1 DAY

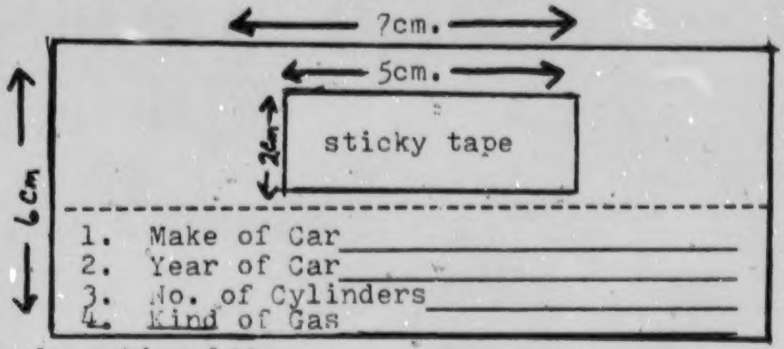
OBJECTIVE: The student will be able to determine the number of particles that fall on ten square centimeters in a given amount of time.

MATERIALS:

6cm. X 7cm. pieces of cardboard
sticky tape
dissecting microscope

PROCEDURE:

1. Cut a 2cm. x 5cm. opening in a thin piece of cardboard and place a piece of wide transparent "sticky" tape on the underside of the cardboard. Prepare the rest of the card as shown in the diagram.



2. In the school parking lot:
   a. choose large, small, old, and new models of cars.
   b. Obtain permission of the car owner.
   c. Measure the diameter of the exhause pipe before starting the motor. *Be sure to keep your face away from the exhaust fumes and do not touch the exhaust pipe.
   d. Start the car's engine and collect exhaust emissions on the cardboard by holding the card directly behind the exhaust pipe.
   e. Operate each engine for the same length of time. (2 min. is suggested)
   f. Record the information on your information card.

3. In the classroom:
   a. Look at the particles under a microscope or magnifying glass. Describe the particles by:
      1. Estimating size of smallest and largest.
      2. Shape of particles.
      3. How many have sharp edges in relation to those which appear rounded and smooth.
      4. How many particles are their per square cm.
   b. Feel the particles. Are they soft or hard and gritty?

RESULTS AND CONCLUSIONS:

1. Which car engines appear to release fewest numbers of particles into the atmosphere. Give reasons which support your findings.

2. Write a short paper listing ways in which the emissions from automobile exhausts are harmful to your health. You might want to consider different areas of the country.

3. How does the area of your collecting tape compare with the exhaust opening?

4. You collected particles for a total of 2 minutes. Estimate the number of particles per square centimeter which would be collected in one hour. Establish the class average and multiply this by the total number of cars in the U.S. to get the number of particles thrown into the air over the U.S. for a period of one hour.

5. Complete and hand in the following chart:

DATE	MAKE OF VEHICLE	YEAR OF VEHICLE	PARTICLE EVIDENCE	# OF MILES DRIVEN SINCE LAST TUNE-UP

6. Does the condition of the engine affect particle emission?

TEACHER FACT SHEET: THE pH OF EXHAUST GASSES

This experiment could be done separately or in conjunction with the experiment on particulates from automobile emissions.

pH of Exhaust Gases

TIME: 1 DAY

OBJECTIVE: The student will be able to compare the pH of air in their area with the pH of exhaust fumes.

MATERIALS: pH paper
tongs
information chart

PROCEDURE:

1. Use a damp piece of pH paper or soak a filter paper in a solution of bromothymol blue. Dip the paper in glycerin to keep it from drying out while it is in the exhaust fumes.

2. Use tongs to hold the paper 2 inches from the exhaust pipe for 2 minutes. Determine the results and record the information on the card provided.

3. Hang a strip of pH or prepared filter paper outside for 24 hours to check the pH of the atmosphere. Compare the results.

RESULTS AND CONCLUSIONS:

1. Is the pH of the air we breathe something that should be considered? Justify your answer.

2. Collect information concerning pH from your classmates.

3. From this information prepare a chart that shows the pH level found in the exhaust of autos of various makes and models.

4. Hand in the chart.

TEACHER FACT SHEET - Sulfur Oxides

When fuels containing sulfur are burned, the sulfur in the fuel joins with the oxygen burned in the air to form oxides of sulfur. Fuel combustion is the major source of sulfur dioxide. Sulfur dioxide is a heavy, pungent, colorless gas that dissolves easily in water vapor to form a solution of sulfurous acid. Sulfurous acid joins slowly with the oxygen in the air to become the more corrosive, irritating mist, sulfuric acid.

Sulfur oxides can cause damage to plant, animal, and human life. In humans it can irritate the upper respiratory tract and affect breathing. Sulfuric acid is responsible for the characteristic dry mouth, scratchy throat, and smarting eyes most city dwellers have experienced. Death can occur if exposed to sulfuric acid for long periods.

TESTING FOR SULFUR DIOXIDE

TIME: 1 Day

OBJECTIVE: The student will be able to compare the sulfur dioxide content of automobile exhaust and relate this to the health problems caused by atmospheric SO_2.

MATERIALS:

large plastic garbage bag
rubber bands
rubber tubing
ice
salt
solution of potassium permanganate; .25 g/1

PROCEDURE:

1. Collect the exhaust gases emitted from the exhaust pipe of an automobile in the plastic garbage bag. (CAUTION: the pipe may be hot. Use gloves if necessary.) Seal the bag with rubber bands and take it back to the lab.
2. Insert rubber tubing into the bag and run the tubing through a bowl of ice and salt to trap moisture. Bubble the gases into a beaker containing the potassium permanganate solution. Record the results.

RESULTS AND CONCLUSIONS:

1. Describe the change in color of the solution.
2. Check the results from other students. Does the age and make of the car have any influence on the data?
3. What are the health hazards which can result from SO_2 in the atmosphere?

TEACHER FACT SHEET - Lead

Much of the lead in the air comes from the compounds used in anti-knock agents in gasoline; tetraethyl lead and tetramethyl lead. About 70 - 80 percent of it is exhausted into the atmosphere in the form of small particles of lead compounds. Of the remaining 20-30 percent about half is scavenged into the lubricating oil and half is retained in the engine and exhaust system. Lead compounds are poisonous, but it is not known precisely how damaging the lead particles from the automobile exhausts are to the environment.

Lead is, however, a cumulative poison and even small amounts continuously present in drinking water could lead to death.

TESTING FOR LEAD

TIME: 1 day

OBJECTIVE: The student will be able to test for lead and will learn that unleaded gasoline helps control lead emissions.

MATERIALS:
- large plastic garbage bag
- rubber bands
- rubber tubing
- ice
- salt
- solution of 20 ml water, 10 ml concentrated acetic acid, and 10 g of chromic anhydride. (CrO_3)

PROCEDURE:

1. Students should choose a variety of automobiles that use regular, premium, and unleaded gasoline. Collect the exhaust emissions from the exhaust pipe of an auto in the plastic garbage bag. (CAUTION: the pipe may be hot. Use gloves if necessary.) Seal the bag with rubber bands and take it to the lab.
2. Insert rubber tubing into the bag and run the tubing through a bowl of ice and salt to trap moisture. Bubble the fumes into a beaker containing the solution of chromic anhydride and observe the results.

RESULTS AND CONCLUSIONS:

1. Compare the results obtained from tests with premium, regular, and unleaded gasoline.
2. Write a paragraph describing the health hazards of lead in the atmosphere.

TEACHER FACT SHEET - Carbon Oxides

CARBON MONOXIDE: Automobiles produce 74% (by weight) of the carbon monoxide found in the air. It is formed in automobiles by incomplete combustion.

Controlled laboratory experiments show that at exposures of 100 ppm most people get dizzy, develop headaches, and feel other symptoms of poisoning. A concentration of 100 ppm is not uncommon in heavy traffic. Some studies have measured 370 ppm inside vehicles in traffic jams.

Carbon monixide poisoning occurs by reducing the mobility of oxygen in the blood, replacing the oxygen molecule in hemoglobin, and causing the hemoglobin molecules to hold on to their oxygen instead of releasing it to cells.

The result of carbon monixide in the atmosphere is unknown. Although more than 300 million tons of CO are formed each year throughout the world, measurements have shown that the average concentration has not changed over the last 50 years.

CARBON DIOXIDE: Carbon dioxide is formed during complete combustion. The more complete the combustion, the more CO_2 formed. Although usually not considered an air pollutant, large quantities can have undesirable side effects. In the presence of moisture it converts to carbonic acid and erodes stone and irrates tissues.

TESTS FOR CARBON MONOXIDE AND CARBON DIOXIDE

TIME: 1 Day

OBJECTIVE: The student will know how to test for carbon monoxide and carbon dioxide in the exhaust of automobiles.

MATERIALS:

- large plastic gargage bag
- rubber tubing
- rubber bands
- ice
- salt
- 500 ml beef blood/group
- lime water solution

PROCEDURE:

1. Collect the exhaust from the exhaust pipe of an automobile in the plastic bag. (CAUTION: the pipe may be hot. Use gloves if necessary.) Seal the bag with rubber bands and take it back to the lab.
2. Carefully insert rubber tubing into the bag. Run the tubing through a bowl of ice and salt to trap moisture. Bubble the fumes into the beaker of beef blood and note any color changes.
3. Bubble the exhaust into a beaker containing the limewater solution. Record the reaction that takes place.

RESULTS AND CONCLUSIONS:

1. Describe the reaction which took place for the carbon monoxide test and for the carbon dioxide test.
2. Using a medical book for reference or other sources, describe the chemical changes which occur in the blood from carbon monoxide poisoning.
3. What health hazards can occur from high concentrations of carbon dioxide?

TEACHER FACT SHEET - Nitrogen Oxides

Nitrogen compounds such as nitrogen dioxide and nitric oxide make up 47% of automobile air pollutants. These have been called status symbol or jet-age pollutants because only a highly advanced country is likely to suffer from them.

Nitric oxide is formed when combustion takes place at temperatures high enough to cause a reaction between the nitrogen and oxygen of the air. It is formed in automobile cylinders and is found, therefore, in most cities.

Nitric oxide, which is relatively harmless, can be converted to nitrogen dioxide. The oxidation can be very rapid at high concentrations in air, but is slow at low concentrations except in the presence of hydorcarbons and sunlight.

It has a yellow-brown color that affects visibility and a pungnet, sweetish odor. At high concentrations, nitrogen dioxide can be fatal, but such high concentrations are rare. Nitrogen dioxide reacts with moisture to form nitric acid which is corrosive and harmful to life.

Teacher Fact Sheet - Hydrocarbons

Hydrocarbons are a class of compounds containing carbon and hydrogen in various combinations. Some are gaseous, some liquid, and some solid. Most are harmful only in very high concentrations.

Some hydrocarbons are needed in the photochemical process of smog production which produces, among other irritants, ozone. (O_3) Ozone can cause coughing, chocking, headache, and severe fatigue.

Another smog product often mentioned is PAN, short for peroxyacyl or peroxyacetyl nitrate. It has been known to make the eyes burn and tear. It has the same irritating effects on the lungs as ozone.

Included in the hydrocarbons are a number of aromatics believed to be carcenogenic. The most potent of these is benzpyrene. It is formed by the incomplete combustion of fuels. The major source of this kind of contamination is the burning of gasoline in automobiles.

POST LAB.

TIME: 2 DAYS

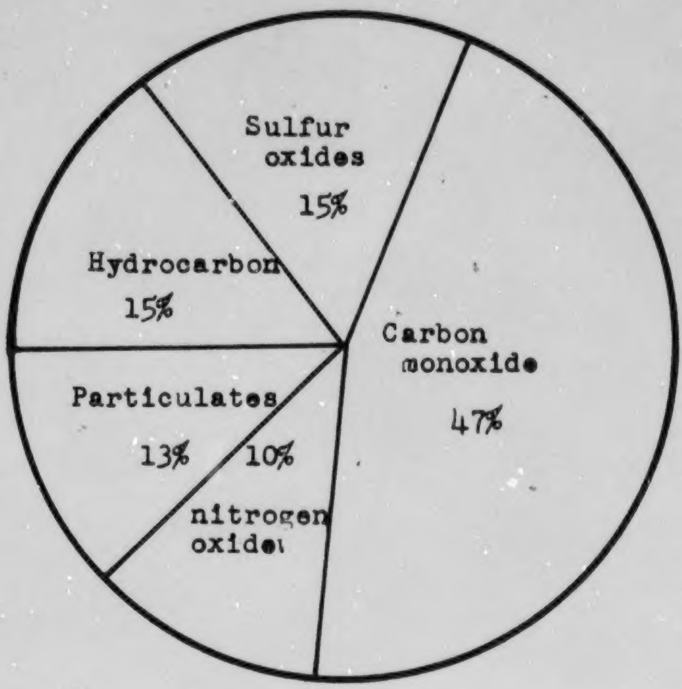
OBJECTIVE: The student will use material learned during this series of lab exercises to perform one of the tasks listed in procedure.

MATERIALS: None.

PROCEDURE:

1. Construct a collage showing how automobile emissions affect human health.
2. Make a table showing individual pollutants from auto. emissions and how each might be related to a particular human ailment.
3. Design and paint a T-shirt depicting how health problems are related to auto. emissions. *These could be worn on a particular day to draw attention to the problem.
4. Speaker.
5. Construct a display for the school library that would draw public attention to this problem.
6. Group discussions to summarize knowledge gained.
7. As a class, develop possible solutions to the problem.
8. Show the film, Automania--2000 (color--10 min.) Available from the UNL film library.

Distribution of Emission Species, Percentage by Weight



Source: "The Automobile and Air Pollution: A Program for Progress", Part II, U.S. Department of Commerce, December 1967.

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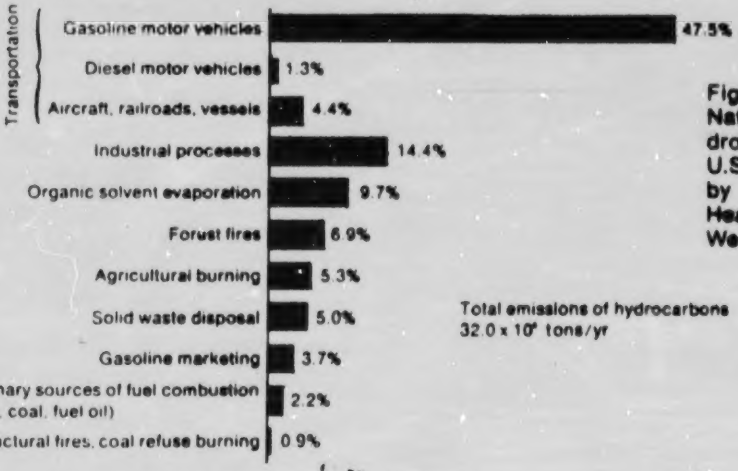
TABLE 12 NATIONWIDE EMISSIONS
(Millions of tons per year)

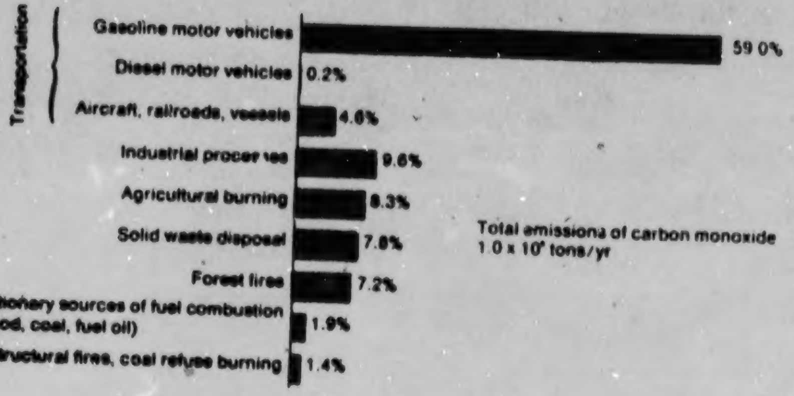
Pollutant source	Motor vehicles	Gasoline	Diesel
Carbon monoxide	59.2	59.0	0.2
Hydrocarbons	15.6	15.2	0.4
Nitrogen oxides	7.2	6.6	0.6
Particulates	0.8	0.5	0.3
Sulfur oxides	0.3	0.2	0.1

City	Benzopyrene level equivalent (cigarettes per day)
Birmingham, Ala.	50
Cincinnati, Ohio	26
Detroit, Mich.	37
Nashville, Tenn.	40
New York, N.Y.	45

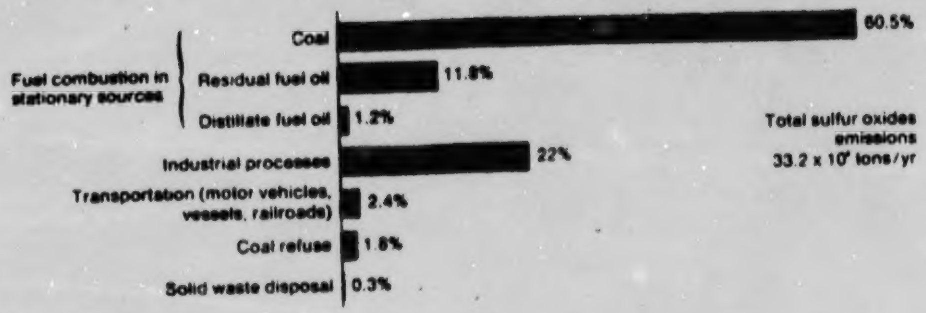


Total emissions of hydrocarbons
32.0 x 10^6 tons/yr

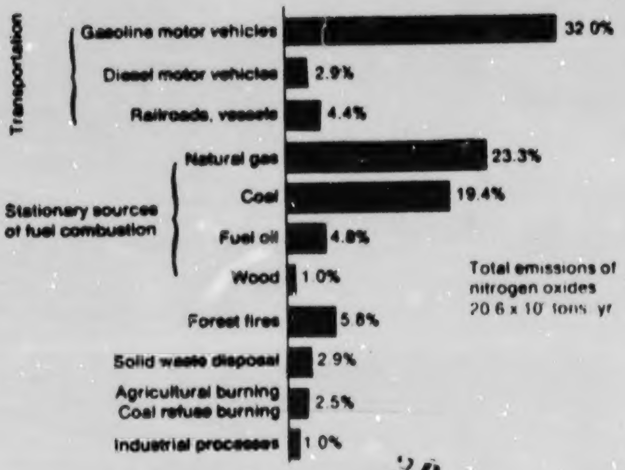
Fig. 4-12
Nationwide sources drocarbon emiss U.S. 1968. (Data pub by U.S. Department Health, Education. Welfare.)



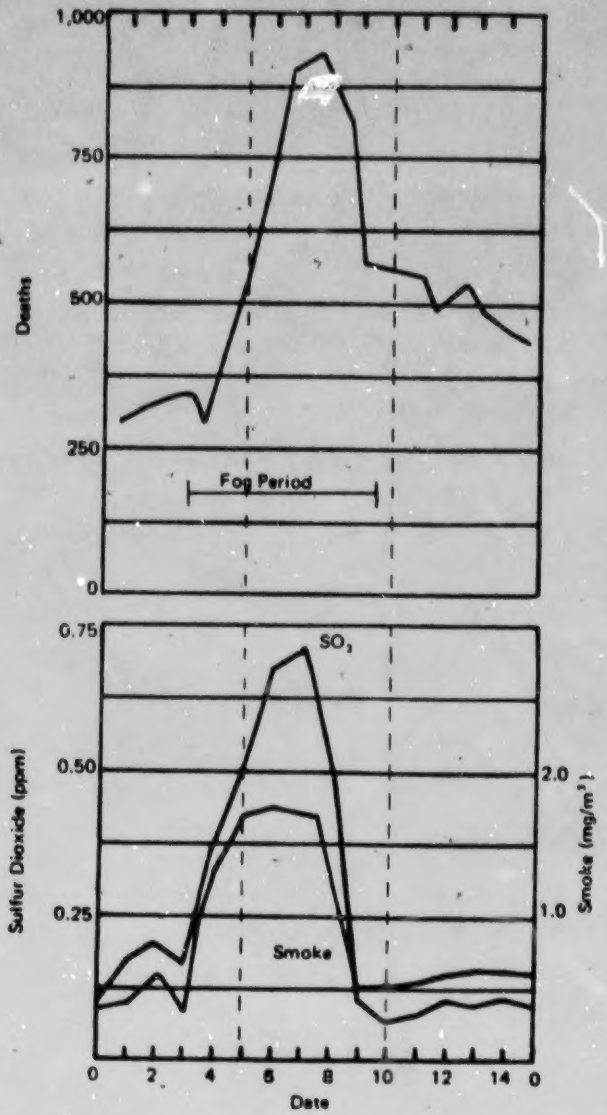
Nationwide sources of sulfur oxides emissions—U.S. 1968. (Data published by U.S. Department of Health, Education, and Welfare.)



Nationwide sources of nitrogen oxides emissions—U.S. 1968. (Data published by U.S. Department of Health, Education, and Welfare.)

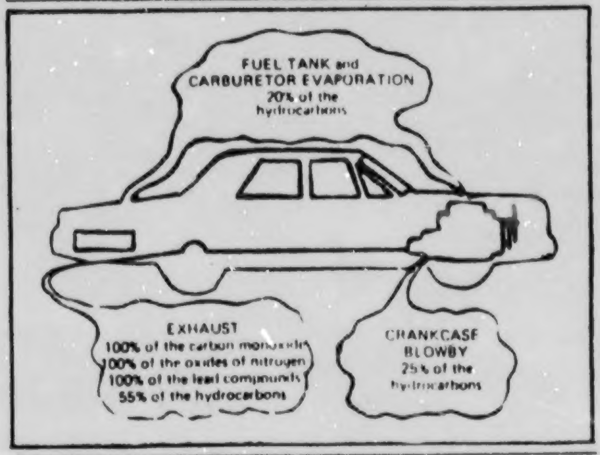


Deaths and Air Pollution in London, 1952

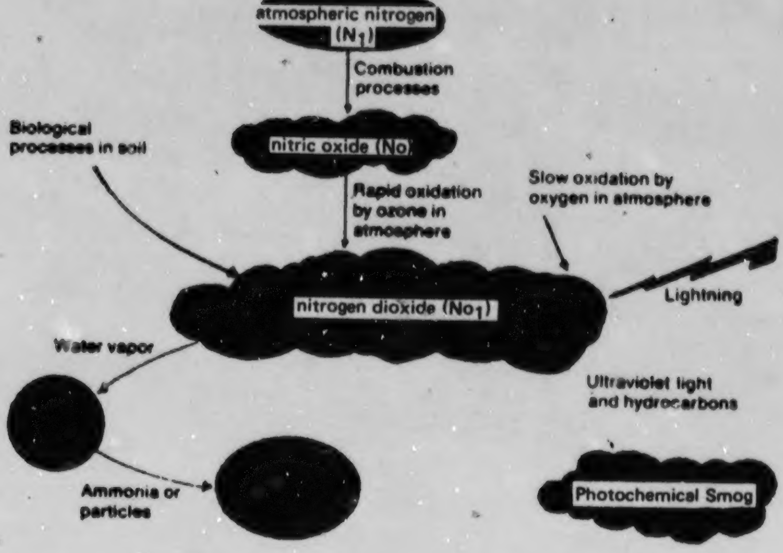


Deaths, sulfur dioxide concentrations, and particulate mass concentrations during the December 1952 episode in London. (After E.T. Wilkins, *Journal of the Royal Sanitation Institute*, 74, 1, 1954.)

Approximate Distribution of Automobile Pollutants by Source

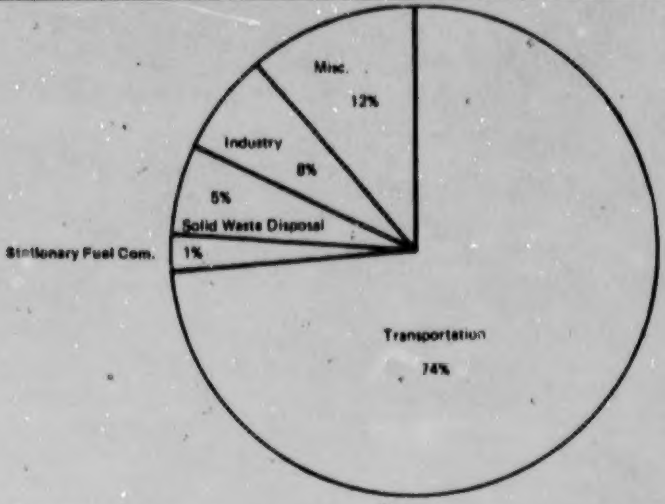

FUEL TANK and
CARBURETOR EVAPORATION
20% of the
hydrocarbons
EXHAUST
100% of the carbon monoxide
100% of the oxides of nitrogen
100% of the lead compounds
55% of the hydrocarbons
CRANKCASE
BLOWBY
25% of the
hydrocarbons

Source: "The Automobile and Air Pollution: A Program for Progress," Part II, U.S. Department of Commerce, December, 1967.


atmospheric nitrogen (N1)
Combustion processes
nitric oxide (No)
Biological processes in soil
Rapid oxidation by ozone in atmosphere
Slow oxidation by oxygen in atmosphere
nitrogen dioxide (No1)
Lightning
Water vapor
Ultraviolet light and hydrocarbons
Ammonia or particles
Photochemical Smog

The production and dispersal of atmospheric nitrogen dioxide.

Sources of the Pollutants



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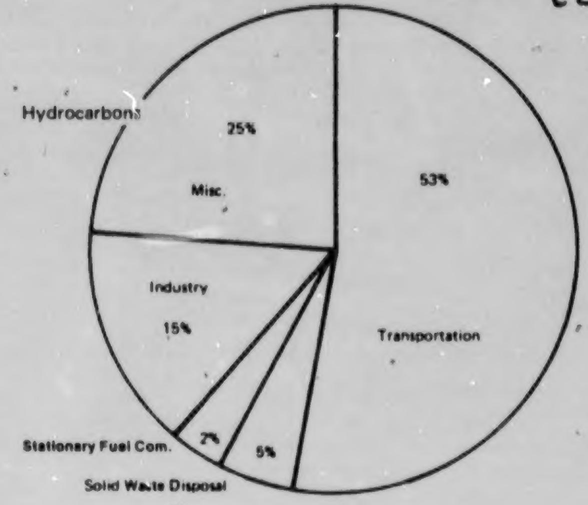

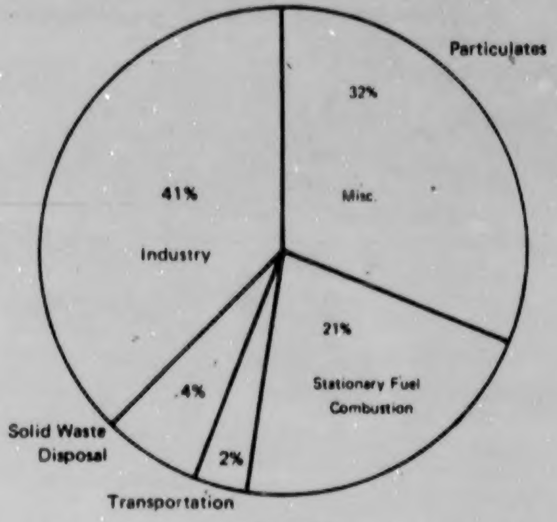

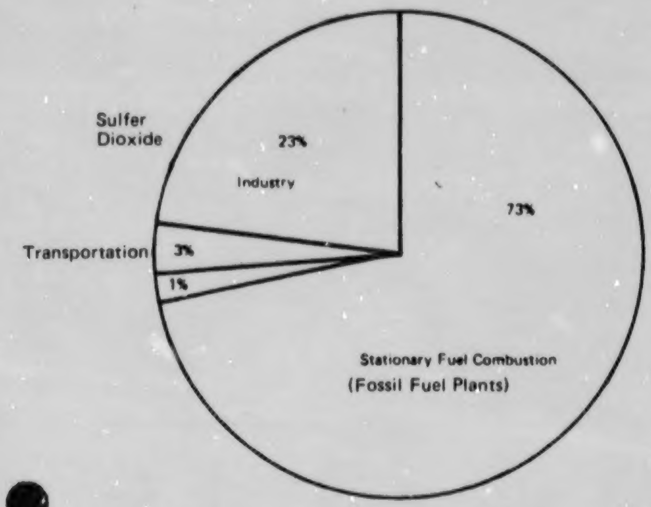

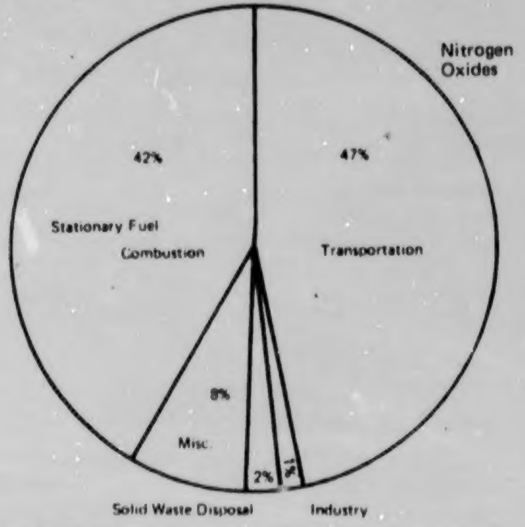

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PHYSICAL LAWS OF ELECTRICAL POWER GENERATION

by
Doug Wilson

Recommended Level: Senior High Physics and/or Chemistry

Time Required: Eight to ten class periods

Prepared for
the Nebraska Energy Office

PHYSICAL LAWS OF ELECTRICAL POWER GENERATION (Doug Wilson)

Abstract

Electricity is what can be called a secondary energy source--it is produced through the use of other sources of energy (primary sources). These primary sources are typically coal, petroleum, natural gas, falling water (hydroelectric) and uranium. Recent estimates show that these primary sources to be providing the following contributions to the U.S. electrical generating capicity: coal = 47%, petroleum = 17%, gas = 13%, water = 12%, and nuclear = 11%.

Because heat is involved in the transformation of energy from most of these primary sources, one must look at the physical processes of energy conversion to develop an understanding of the limitations imposed upon these means of electrical generation.

Recommended Level

Senior high physics and/or chemistry

Time required

8 to 10 days

Major Teaching Strategies

The majority of the student time will be spent involved in data collection, data analysis and calculations from supplied information. The teacher will need to provide some basic procedures for calculations and assistance to individual students.

Essential Advanced Preparation

The attempt in writing this instructional lesson had to make it self-inclusive with all necessary materials contained within. Its impact upon students can be enhanced through the use of an electric utility representative as a resource speaker and/or an appropriate field trip. Teachers unfamiliar with all of the energy, mass, weight and temperature units involved in the calculations will need to seek assistance from a physics text or visit with someone in the community having such familiarity.

Goals

---Students will become familiar with the law of thermodynamics involved in the generation fo electrical energy.

---Students will gain a sense of the magnitude of the electrical generation process.

---Students will develop competence in the use of numerical data for expressing energy unity and their relation to heat and electrical energy production and use.

Objectives

Student will be able to;

name the major parts of an electrical generating plant and describe the function of each.

explain the meaning of the First and Second Laws to Thermodynamics and give illustrations of their application.

calculate the heat absorbed by a given quantity of water when supplied with ample temperature data.

calculate the temperature change of a given quantity of water when given the energy input.

determine the efficiency of a system given either thermal or mechanical energy inputs and outputs.

convert electrical units to heat units and vise versa.

determine kilowatt-hours of energy from electrical power and time data.

convert watts to kilowatts and megawatts and vice versa.

propose modifications to thermal systems to improve the efficiency of these systems and will project the consequences of these modifications.

Number of Daily Lessons Recommended

1. Introduce the topic of electrical power generation by having students verbally list the electrical equipment items in their homes and then to prioritize these in terms of need. Group can be questioned as to how they think electricity is generated and delivered to their homes. Keep a list of energy units which result from this discussion. At the end of the session, hand out student reading and laboratory materials.

2. Begin discussion with some of the data presented in the Abstract and in the student reading and develop a discussion on what problems might arise from this mix of energy sources. Pose questions as to what they see happening to the electrical demand situation in the U.S. and to the demand for petroleum imports. Demonstrate the use of equipment to be used in Experiment 1, the relationship between heat and electricity and assign this experiment for the following day.

3. After a brief questioning session to make certain that all understand the procedures for the experiment, have them procede with the collection of the data and its analysis. They will need some assistance with the analysis part of the experiment.

4. Discuss results of Experiment 1 and turn their attention toward the reading concerning electrical power generation. Transparencies of the data table and the power plant diagram could be used effectively at this point. A brief introduction to the topic of efficiency at this time will provide a lead-in to Experiment 2. Demonstrate the use of the equipment to be used in this experiment and assign this for the reading for the next day's use.

5. After a brief questioning session to make certain that all are familiar with the procedures to be followed, have them begin work on Experiment 2, Determining the Efficiency of a Light Bulb

6. Discuss the results of Experiment 2 and relate these results to the efficiencies discussed in the reading and to the problems relating to efficiency.

7. Conclude discussion of the reading and assist students with problem calculations. The attention to problems may need to be carried into the following day's lesson.

8. Give the students a test containing problems and questions based upon the objectives. These can be similar to those in the learning packet--but their level of difficulty will depend upon the learning level of one's particular student group.

***If a resource speaker is available, having their presentation prior to lesson 5 would appear appropriate.

Evaluation Suggestions

See note for lesson 8 above.

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PHYSICAL LAWS OF ELECTRICAL POWER GENERATION

Electricity is a very familiar and convenient source of energy. Energy present in a fossil or nuclear fuel is converted to energy in a form which is then transported by means of wires and readily distributed to residential, commercial and industrial customers.

Electricity is a useful carrier of energy since it is easily transported with little loss, methods have developed during the past 80 years for the safe handling of electricity, and the techniques of converting fossil and nuclear fuels to electric power are will developed, reasonably economical, and relatively safe.

In 1976 an estimated two trillion kilowatt-hours of electrical energy were generated in the U.S. with coal contributing 47 percent, oil 17 percent, natural gas 13 percent, hydroelectric 12 percent; and nuclear 11 percent. This electricity was used by the consuming sector as follows: residential 32 percent, commercial 23 percent, industrial 41 percent, and others 4 percent.

While electricity is relied upon as a major source of energy in the U.S., the generation of this electricity is a very expensive process from the standpoint of the conversion of fuel from one energy source to another. Another way of expressing this expense is to examine the efficiency with which this transformation is achieved.

U.S. Disposition of Energy in 1976
(in 10^6 bbl. of oil equivalents/day)

	Consumed	Converted to Useful Work	Wasted Energy	Efficiency (%)
Utilities	10.0	3.2	6.8	32.0
Industry	10.0	5.0	5.0	50.0
Residential	5.3	2.1	3.2	39.6
Autos	4.8	0.6	4.2	12.5
Other Transportation	4.5	0.5	4.0	11.1
Commercial	3.0	1.2	1.8	40.0
Other	0.7		0.7	
Total	38.3	12.6	25.7	32.9

Newsweek, April 18, 1977

We typically define efficiency as the ratio of work taken from a system to the work put into that system. That system may be an automobile in which the work taken from the system is the work done by the motor in moving the auto and the work put into the system is the work potential contained in the chemical energy of the gasoline. If the system is an electrical generating plant, the work taken from the system is all of the electrical energy made available to the consumers and the work input consists of the chemical or nuclear energy possessed by the fuel used in powering the electrical generator.

Automobiles and power plants are not alone in suffering from efficiency losses. While autos and power plants are typically about 25 per cent and 35 per cent efficent, respectively, other energy consuming sectors of the U.S. suffer similar inefficiencies as indicated by the table above. As can be seen, America loses about two-thirds of the energy it consumes. Part of the reason for this loss is because there are absolute physical limits to efficiency (as will be discussed briefly in a later section).

A more detailed account of the energy flow within the U.S. consuming sector can be seen in the diagram below. If we examine the efficiency of electrical generation, we find that only 5.3 Q (quads) of useful energy emerge from the 15.1 Q of energy placed into the electrical generation process.

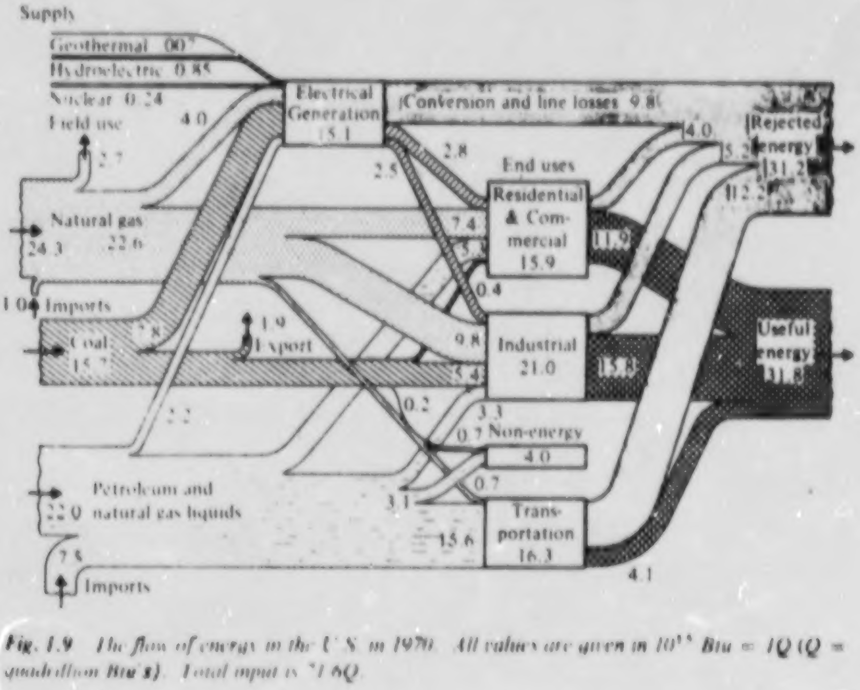

Supply
Geothermal 0.07
Hydroelectric 0.85
Nuclear 0.24
Field use
4.0
2.7
Natural gas
24.3
22.6
1.0 Imports
Coal
15.7
7.8
1.9
Export
2.2
Petroleum and natural gas liquids
22.0
7.5
Imports
Electrical Generation 15.1
Conversion and line losses 9.8
2.8
2.5
End uses
Residential & Commercial 15.9
7.4
5.3
0.4
9.8
5.4
Industrial 21.0
0.2
3.3
0.7 Non-energy
4.0
0.7
3.1
15.6
Transportation 16.3
4.1
4.0
5.2
12.2
Rejected energy 31.2
11.9
15.8
Useful energy 31.8

Fig. 1.9 The flow of energy in the U.S. in 1970. All values are given in 10^{15} Btu = 1Q (Q = quadrillion Btu's). Total input is 71.6Q.

Dorf, Richard C. Energy, Resources, and Policy
(Reading, Mass.) Addison-Wesley Publishing Co.,
1978, p. 9.

40

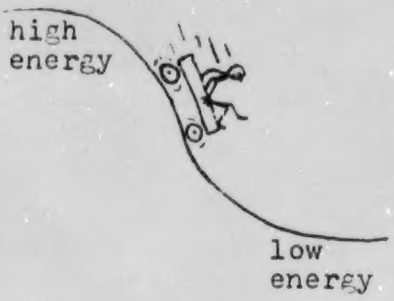
The efficiency of such a process would be calculated as follows:

$$\text{efficiency} = \frac{\text{energy (work) output}}{\text{energy (work) input}} = \frac{5.3\ Q}{15.1\ Q} = 0.35 = 35\%$$

The total energy utilized in the U.S. during 1970 is shown to be 71.6 Q. If only the four major sectors of energy use are considered, 31.8 Q of a total of 63.0 Q (31.8 Q + 31.2 Q) was converted to useful work. The efficiency of use by these four sectors calculates to be 50.5%. More recent data indicate that the efficiency of these four sectors is lessening, partially due to increased dependence upon low-efficiency electrical generation, airplane and automobile transportaion.

We Must Follow The Rules

The electrical generating plant is an excellent illustration of how some physical laws relate to the problem of efficiency. To understand what this means in the grand scheme of things, we need to examine some basic physics. The First Law of Thermodynamics tells us that no matter or energy can be created or destroyed, just changed in form. Coal becomes electricity and heat, iron ore becomes an automobile. But then the Second Law of Thermodynamics comes along and says, yes, something is destroyed--not the energy or matter itself, but the usability of it.



We might consider the sketch at right as an illustration of a system in which energy is undergoing a change. When the wagon is at the top of the hill, it has a high energy relative to the bottom of the hill. As it rolls down the hill, its energy of position (potential energy) is converted into energy of motion (kinetic energy). It finally reaches the bottom of the hill and gradually rolls to a stop because of various kinds of friction. We might say that when it reaches the bottom of the hill it has lost all of its potential energy. But, has it? Not really. If the bottom of the hill had been lower, it could have lost more energy. But, given this hill, there is only a certain amount of energy that the wagon can lose.

If we want to return to the top of the hill, what must we do? We must put some work (energy) into the system. But, can we get by with only the amount of energy we lost in rolling down the hill? Not quite. Friction requires that we add a bit more energy than we appear to lose. In fact, we lose energy due to the work done in overcoming friction in both climbing the hill and in rolling down it. That work done against friction is just simply lost. It has become the unusable energy mentioned in the Second Law of Thermodynamics.

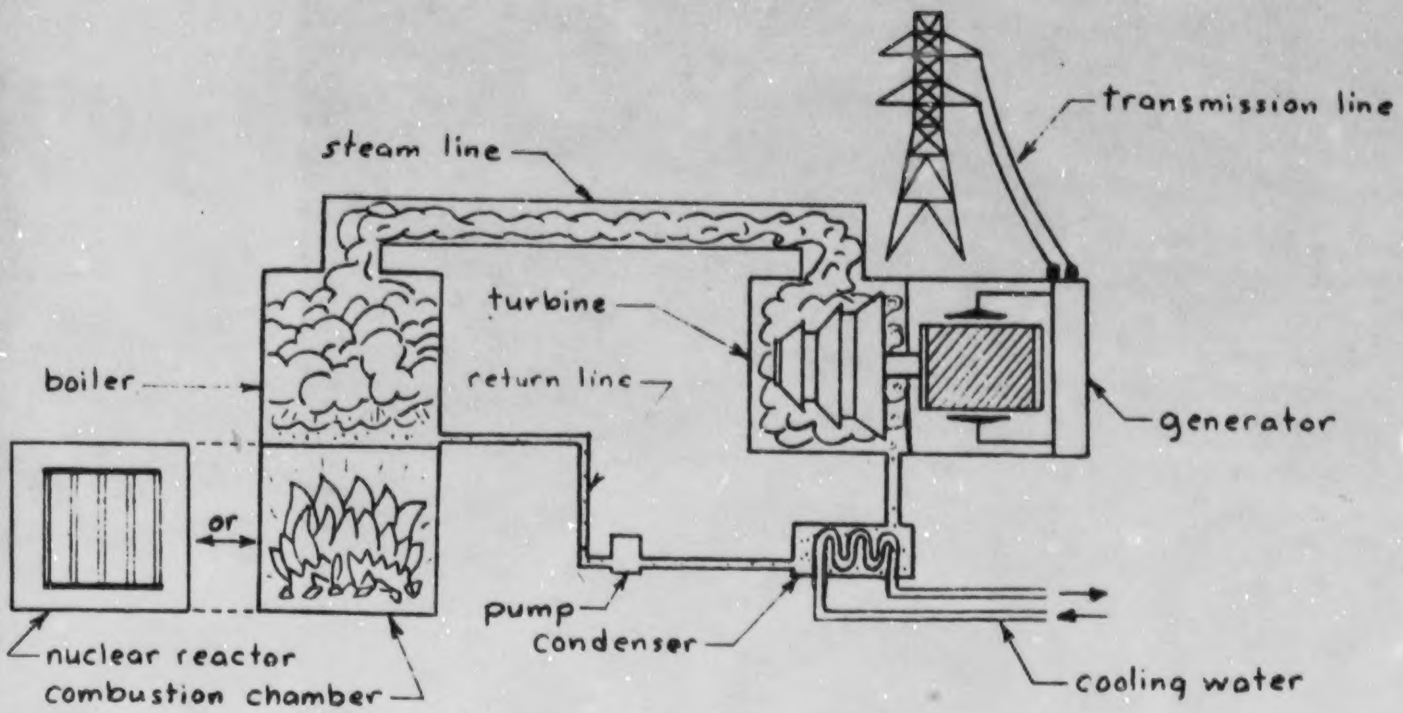
Examine the diagram of the electric generating plant shown on the following page. Quite simply, water in the boiler is heated to a very high temperature until it becomes high-pressure steam. This steam "falls" through a turbine--doing work on the turbine by causing it to turn. The steam reaches the bottom of its "energy hill" when it leaves the turbine and becomes water again in the condenser. It must now be returned to the top of the energy hill by being pumped into the boiler and reheated.

Getting Steamed Up

The water in the boiler is heated to a very high temperature (600 to 1200°F) by means of a fossil or nuclear fuel. Like the pressure cooker used in many homes, a rise in pressure (1000 to 2000 lb/in^2) also occurs. Because heat only flows effectively between areas of vastly different temperature, the temperature of the burning fuel is many hundreds of degrees hotter than the temperature of the steam (typical combustion temperatures will be around 2800°F). Heat generated by combustion which is not absorbed by the steam, passes from the combustion chamber through a tall smoke stack. This loss is typically about 10 to 12 per cent of the heat content of the hundreds of tons of fuel burned per hour. If nuclear fuel is used, essentially no heat is lost at this step.

Getting Cooled Down

The superheated steam from the boiler is transported from the boiler to a turbine by means of highly-insulated pipes. It arrives at the turbine (a device consisting of many sets of blades mounted on a common shaft) and begins its journey through a maze of blades. Because of the steam's high temperature and pressure, it begins the journey by pushing against blades of fairly small size. As it loses temperature and pressure (energy loss from doing work), the blades it encounters become progressively larger in size so that work can still be effectively extracted from it. When the steam reaches the last set of blades, it is still hot and under some pressure. But its effectiveness as a working fluid has diminished to the point where it is not practical to attempt to remove any further work from it.


transmission line
steam line
turbine
boiler
return line
generator
or
pump
condenser
nuclear reactor
combustion chamber
cooling water

ELECTRIC GENERATING PLANT

It is now desired to get this cooled and tired steam out of the way as quickly as possible to make room for the more energetic steam following behind. The condenser serves the purpose of rapidly changing the spent steam into water by removing some of its remaining heat. This removal is accomplished by passing the steam through pipes which are surrounded by cold water. This cold water is typically pumped from a river or lake to the condenser where it gains heat from the condensing steam and is then discharged from the condenser several degrees warmer than when it entered (commonly 10 to 20°F). This warmed water is then placed back into a river or lake or sent to some type of cooling tower where its extra heat is expelled into the air. This cooling water frequently flows through the condenser at a rate of several hundred thousand gallons per minute and will remove approximately 50 to 60 per cent of the heat energy originally carried by the steam as it entered the turbine.

This cooling loss is the most significant energy loss in the entire generating process. We might think again of the diagram showing the wagon rolling down a hill. The steam at the entrance to the turbine is at the top of its "energy hill" and it loses energy to the turbine as it moves down the energy hill. The bottom of the hill occurs when it leaves the turbine. There are lower hills to which it may fall, however, it is not practical to allow it to do so. Absolute zero (-459°F) would be the lowest hill possible, but water freezes at 32°F. Water colder than that of river or lakes is not practical because of the energy that would be consumed in its cooling.

Physicists sometimes use an efficiency formula involving temperature to express the energy losses due to the temperature changes in a turbine. This formula is:

$$\text{eff.} = \frac{T_1 - T_2}{T_1}$$

T_1 = initial temperature (absolute)
T_2 = final temperature (absolute)

If we apply this formula to a turbine where the initial temperature is 800°F (1259°A) and the final temperature is 100°F (559°A), an efficiency of 56% results. Try it!

An additional source of loss in the condensing cycle is due to the energy consumed in pumping the water back into the boiler. Remember, it must be pumped into an area where the pressure is approximately 1000 to 2000 lb/in^2. Think of the work involved in pumping up a bicycle tire to a pressure of only 60 or 70 lb/in^2.

It's Electrifying

The generator turned by the turbine is a very complex machine weighing many, many tons. A very dense magnetic field is caused to intercept several miles of wire. This action of wires cutting across a magnetic field produces an electrical force, resulting in the current we use in our homes. Although generators are very efficient, there is some energy loss (typically about 1%) due to heat produced in this device.

The current from the generator is sent to a transformer where its voltage is multiplied many times (with an added loss of approximately 1%). To carry this resulting electrical energy to the consumer, many miles of wires are used and several more transformers. This is called the transmission process. This process may cause an additional 5 to 10% loss in energy, depending upon the distance which the electrical energy must be carried.

What's The Return?

When we look at the total electrical generating and distributing process, it is obvious that the major portion of the chemical or nuclear energy available in a fuel is not available to the consumer as electrical energy. It is not unusual to have only 30 per cent of that initial amount delivered as useful energy. But, those are the rules and we must live by them. We cannot break the rules--we can only search for ways to play the power game more efficiently by minimizing heat losses where possible and making the best use of that small fraction of energy which is finally provided to us.

Your Turn

You can now try your hand at determining how efficient one power plant is by using the information provided below. In your calculations, try to determine how much hotter the cooling water might become if all but 15 per cent of the waste heat is absorbed by this water.

Generating capacity - - - - - 225,000 kilowatts
Cooling water - - - - - - - 120,000 gallons per minute
Coal consumption - - - - - - 110 tons per hour
Coal heat content - - - - - - 12,500 Btu per pound

1 kilowatt-hour = 3415 Btu
1 gallon of water = 8.3 lb
1 ton = 2000 lb

1 Btu is the heat required to change the temperature of 1 pound of water 1 Fahrenheit degree.

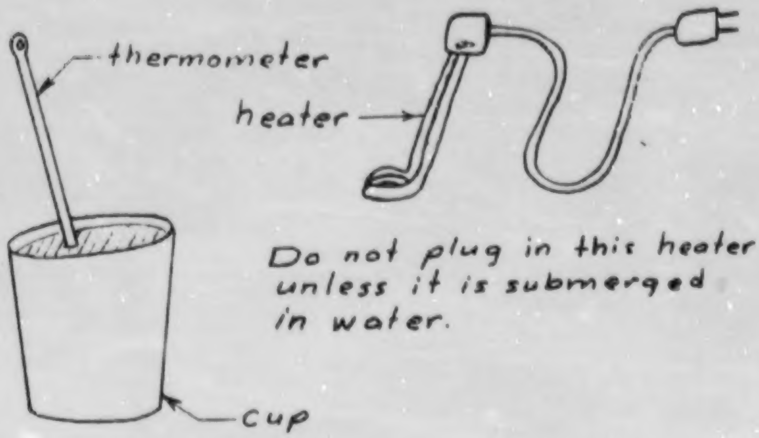
Experiment 1 - THE RELATIONSHIP BETWEEN HEAT AND ELECTRICITY

Electricity as a form of energy for heating has become very common-place in the American home. The modern kitchen, in particular, has numerous appliances whose sole purpose is that of producing heat.

In this experiment you will explore the electricity-heat relationship by using a simple electric heating coil to warm water. Through the use of data collected during the heating process, the heating ability of elctrical energy can be more fully understood.

Materials:

- 8 to 14 oz styrofoam cup
- thermometer
- 100 ml graduated cylinder
- one-cup electric heater (available in variety stores)



Do not plug in this heater unless it is submerged in water.

Collecting the Data

A. Place a 150 to 200 ml carefully measured volume of water into the cup and determine its temperature to the nearest 1/10 degree.

Place the electric heater into the water so that the coil is submerged as completely as possible. Do not submerge the plastic top. Plug in the heater for one minute and then unplug it. Gently stir the water with the unplugged heater for a few seconds and determine the temperature of the warmed water to the nearest 1/10 degree.

Remove the heater from the water and examine it for electrical information to determine its watt rating. For example, 225 W will mean 225 watts.

B. Repeat Procedure A allowing the heater to operate for two minutes.

Processing the Data

Scientists and engineers use slightly different units when working with heat and electricity. To familiarize you with both systems of units, you will first use those units used by scientists and then those used most frequently by engineers.

1. For both procedures A and B, determine the quantity of heat added to the water by using the following relationship:

   $Q = mc\Delta T$ Q = heat in calories
   m = mass of water in grams (1 ml = 1 g)
   c = heat constant for water (1 cal/g.C^{o})
   ΔT = temperature change of water (C^{o})

2. Using the relationship, 1 W = 14.3 cal/minute, claculate the quantity of heat supplied by the electrical heater for both Procedures A and B.

3. Ideally, the heat values determined in Step 1 should be equal to the heat values found in Step 2. If they are not equal, examine their differences and suggest reasons for this variation.

4. Engineers use the same mathematical relationships as scientists for determining the heat gain of a substance, but the units are different. One of the first differences is in expressing the weight of the water. Determine the weight of water in the cup for each trial by using the following conversion:

   453.6 g = 1.0 lb

   Next convert each of the temperature readings to Fahrenheit units by use of the following equation:

   $F = 1.8C + 32$

   We can now use the statement:

   $Q = mc\Delta T$ Q = heat in Btu's
   m = weight of water in pounds
   c = Heat constant for water (1 Btu/lb.F^{o})
   ΔT = temperature change in Fo

5. While engineers use the watt as a unit of electrical power, they find it more useful in their work to determine the kilowatt-hours of energy and then convert this value (kWh) into Btu's. For example, 225 W for one minute would be

   0.225 kW x 1/60 hr = 0.00375 kWh

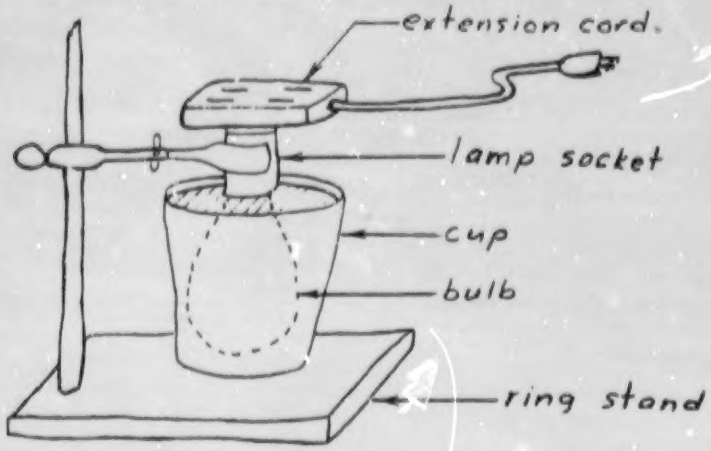
Experiment 2 - Determining the Efficiency of a Light Bulb

The ordinary light bulb is a very common means of converting electrical energy into light energy. Because the light is produced from a white-hot tungsten filament within the bulb, some of the electrical energy is converted to heat. This experiment is designed to provide a measure of the quantitites of heat and light energies transformed from electrical energy.

Caution: Be sure light bulb is immersed in the water as shown before connecting to power souice

Materials:

- ring stand
- buret clamp
- 8 to 14 oz styrofoam cup
- 40 to 100 W light bulb
- 100 ml graduated cylinder
- extension cord
- lamp socket (plug-in type)
- black ink or Tempra paint
- thermometer



Collecting the Data

Note: The bulb must be small enough so that it does not touch the sides of the cup when its glass envelope is totally submerged. Leave about 1/4 inch between the surface of the water and the rim of the lamp socket.

A. Arrange the materials as shown in the diagram above. Add water to the cup until it reaches a level just below the rim of the lamp socket. Place a thermometer into the cup and determine the water temperature accurate to the nearest 1/10 degree.

They make the conversion to Btu's through the use of the following conversion relationship:

1 kWh = 3415 Btu

Using the wattage data for your electric heater, the time it was plugged in, and the above conversion relationship, calculate the quantity of heat delivered by the heater in each trial.

6. Try this problem to test your ability to work with the engineer's system of units:

   A 1500 W heater is placed in an insulated tank containing 200 lb of water at 50°F. The heater is operated for 15 minutes. What will be the temperature of the water after this period of heating?

   If you carried out the procedures and calculations carefully, you should arrive at a temperature of 56.4°F.

Plug in the extension cord for one minute and then unplug it. Gently stir the water with the thermometer for a few seconds and read the new temperature accurate to the nearest 1/10 degree.

Remove the bulb from the cup and pour the water into a graduated cylinder to determine its volume and mass (1 ml = 1 g).

B. Repeat Part A for 2 minutes.

C. Repeat Part A using a mixture of ink (or black Tempra paint) and water which forms an opaque mixture.

D. Repeat part C for 2 minutes.

Processing the Data

1. Calculate the heat absorbed by the water for each of the above parts through the use of the following formula:

$Q = mc\Delta T$ Q = heat absorbed by the water in calories
m = mass of water in grams
c = heat constant for water ($1\ cal/g\cdot C^{o}$)
ΔT = change in temperature of water in C^{o}

2. Determine the electrical energy consumed by the bulb by using the following table:

bulb size (watts)	energy consumption (cal/minute)
25	358
40	573
60	860
75	1074
100	1432

3. Calculate the electrical energy not converted to heat (light energy) for each part as follows:

light energy = electrical energy - heat energy

4. Calculate the lighting efficiency of the bulb for each part by using the following relationship:

$$\text{efficiency} = \frac{\text{light energy}}{\text{electrical energy consumed}}$$

5. What is the effect of placing the ink (or paint) in the water?

Data conversions for Conventional System (if desired)
1 W = 0.057 Btu/minute
453.6 g = 1 lb
1 C^{o} = 1 F^{o}

Problems:

1. Express each of the following in watts (W):
    - a. 2.1 kW
    - b. 45.8 kW
    - c. 1.5 MW
    - d. 1200 MW
    - e. 0.010 kW
    - f. 0.650 kW
    - g. 0.0002 MW
    - h. 0.055 MW

2. Express each of the following in kilowatts (kW):
    - a. 1000 W
    - b. 60 W
    - c. 1200 W
    - d. 4 W
    - e. 50,000 W
    - f. 8×10^5 W
    - g. 60×10^6 W
    - h. 1,000,000,000 W

3. Express each of the following in megawatts (MW):
    - a. 1,000,000 W
    - b. 1,000,000,000 W
    - c. 800,000 W
    - d. 800,000,000 W
    - e. 60,000 W
    - f. 46,000,000,000 W
    - g. 77×10^{15} W
    - h. 12×10^6 W

4. Express the following electrical usages in kilowatt-hours (kWh):
    - a. 800 W used continuously for 15 hr.
    - b. 1500 W used 15 minutes daily for 30 days.
    - c. 4 W used continuously for 30 days.
    - d. 4.5 kW used 10 minutes per hour for 30 days.

5. Using the relationship that 1 kWh = 3415 Btu, make the following conversions:
    - a. 5 kWh = _____ Btu
    - b. 8000 Btu = _____ kWh
    - c. 0.050 kWh = _____ Btu
    - d. 300 Btu = _____ kWh
    - e. 9400 kWh = _____ Btu
    - f. 100,000 Btu = _____ kWh

6. A common light bulb has an electrical power rating of 100 W.
    - a. Express this rating in kilowatts (kW).
    - b. If the bulb is operated 80 hours, how much energy will it consume in kilowatt-hours?

7. The electric heater used to warm the ticket booth at a football game has an electrical power rating of 1500 W.
    - a. How many kilowatt-hours of energy will this heater consume during a 3 hour period?
    - b. How much heat (in Btu's) will the heater produce during this 3 hour period?

8. Calculate the heat (in Btu's) required to warm the following quantities of water by the indicated amounts.
    - a. 10 lb of water from 50°F to 80°F.
    - b. 45 lb of water from 50°F to 120°F.
    - c. 500 lb of water from 55°F to 140°F.
    - d. 62.4 lb of water from 35°F to 180°F.

9. For each of the following quantities of heat added to the amount of water listed, calculate the temperature change which would occur to the water.
   a. 1000 Btu added to 20 lb of water.
   b. 6000 Btu added to 400 lb of water.
   c. 5×10^4 Btu added to 350 lb of water.
   d. 4.5×10^6 Btu added to 2.4×10^5 lb of water.

10. A 50 gallon tank of water is to have its temperature raised from 60°F to 130°F.
   a. How many Btu's of heat will be required to carry out this task if each gallon of water weighs 8.3 lb?
   b. If 1 kWh of electrical energy produces 3415 Btu, how many kWh will be needed to supply this quantity of heat?

11. The furnace of a house burns natural gas at a rate which provides 100,000 Btu/hr. Yet, only 80,000 Btu/hr is removable from the furnace in the form of useful heat (the remaining 20,000 Btu/hr escaping up the chimney). What is the efficiency of the furnace?

12. A gasoline motor is 25% efficient. It burns 3 gallons of gasoline per hour.
   a. If the gasoline has a heat value of 140,000 Btu/gallon, how much heat is wasted by the motor per hour?
   b. If the motor operates a 95% efficient electrical generator, how many kilowatts of power will the generator produce?

13. When coal is burned, it typically yields heat of approximately 13,000 Btu/lb. How much heat would be produced from the burning of 1 ton of coal?

14. A small electrical power plant burns 110 tons of coal per hour.
   a. If the heat content of the coal is 13,000 Btu/lb, how many Btu's of heat will be produced per hour?
   b. If all of this heat could be converted into electrical energy, what would be the electrical generating capacity of the plant in kilowatts?
   c. The plant is found to have an operating efficiency of 27%. What is the actual generating capacity of the plant in kilowatts?

15. The power plant in the above problem uses water flowing at the rate of 120,000 gallons per minute to extract waste heat from the condenser of the turbine.
   a. How many gallons of water flows through the condenser per hour?
   b. What weight of water flows through the condenser per hour?
   c. If 60% of the heat lost by the plant is lost in the turbine, what quantity of heat is carried away by the cooling water per hour?
   d. When the cooling water leaves the condenser, how many degrees higher in temperature has it become compared to when it entered the condenser?

16. During which part of the electrical generating process is the greatest amount of heat lost? What is the second greatest area of loss?

17. Nuclear plants do not lose heat through a smokestack as do fossil fuel plants, yet they are somewhat less efficient in terms of electrical energy generated from heat produced in the boiler. What might be different about the nuclear plants that could account for this reduced efficiency?

18. A turbine has an inlet temperature of $600^{\circ}F$ and an outlet temperature of $80^{\circ}F$. What is the efficiency of the turbine?

19. Outline some procedures which might be used to make power plants more efficient in those areas where the greatest energy losses occur. What problems might be encountered if these procedures were carried out?

Answers to Problems:

1. a. 2100 W — e. 10 W
   b. 45,800 W — f. 650 W
   c. 1,500,000 W — g. 200 W
   d. 1,200,000,000 W — h. 55,000 W

2. a. 1 kW — e. 50 kW
   b. 0.06 kW — f. 8×10^2 kW
   c. 1.2 kW — g. 60×10^3 kW
   d. 0.004 kW — h. 1,000,000 kW

3. a. 1 MW — e. 0.06 MW
   b. 1000 MW — f. 46,000 MW
   c. 0.8 MW — g. 77×10^9 MW
   d. 800 MW — h. 12 MW

4. a. E = 0.8 kW x 15 h = 12 kWh
   b. E = 1.5 kW x ¼ h/day x 30 day = 11.25 kWh
   c. E = 0.004 kW x 24 h/day x 30 day = 2.88 kWh
   d. E = 4.5 kW x 1/6 h/h x 24 h/day x 30 day = 540 kWh

5. a. Q = 5 kWh (3415 Btu/kWh) = 17,075 Btu
   b. E = 8000 Btu / 3415 Btu/kWh = 2.34 kWh
   c. Q = 0.050 kWh (3415 Btu/kWh) = 171 Btu
   d. E = 300 Btu / 3415 Btu/kWh = 0.088 kWh
   e. Q = 9400 kWh (3415 Btu/kWh) = 3.21×10^7 Btu
   f. E = 100,000 Btu / 3415 Btu/kWh = 29.3 kWh

6. a. 0.1 kW   b. E = 0.1 kW x 80 h = 8 kWh

7. a. E = 1.5 kW x 3 h = 4.5 kWh
   b. Q = 4.5 kWh x 3415 Btu/kWh = 15,370 Btu

8. a. Q = 10 lb x 1 Btu/lb·F° x 30 F° = 300 Btu
   b. Q = 45 lb x 1 Btu/lb·F° x 70 F° = 3150 Btu
   c. Q = 500 lb x 1 Btu/lb·F° x 85 F° = 42,500 Btu
   d. Q = 62.4 lb x 1 Btu/lb·F° x 145 F° = 9050 Btu

9. a. ΔT = 1000 Btu / (1 Btu/lb·F°)20 lb = 50 F°
   b. ΔT = 6000 Btu / (1 Btu/lb·F°)400 lb = 15 F°
   c. ΔT = 5×10^4 Btu / (1 Btu/lb·F°)350 lb = 143 F°
   d. ΔT = 4.5×10^6 Btu / (1 Btu/lb·F°)(2.4×10^5 lb) = 18.8 F°

10. a. weight = 50 gal x 8.3 lb/gal = 415 lb
    Q = 415 lb x 1 Btu/lb·F° x 70 F° = 29,050 Btu
    b. E = 29,050 Btu / (3415 Btu/kWh) = 8.5 kWh

11. eff = 80,000 Btu/h / 100,000 Btu/h = 0.80 = 80%

12. a. 0 = 3 gal/h x 140,000 Btu/gal x 0.75 = 315,000 Btu/h
    b. E = 3 gal/h x 140,000 Btu/gal x 0.25 x 0.95 / (3145 Btu/kWh) = 29.2 kW

13. Q = 1.3 x 10^4 Btu/lb x 2000 lb/ton = 2.6 x 10^7 Btu/ton

14. a. Q = 1.3 x 10^4 Btu/lb x 2000 lb/ton x 1.10 x 10^2 ton/h = = 2.86 x 10^9 Btu/h
    b. E = 2.86 x 10^9 Btu/h / (3415 Btu/kWh) = 837,000 kW
    c. E = 0.27 x 837,000 kW = 226,000 kW

15. a. V = 1.2 x 10^5 gal/min x 60 min/h = 7.2 x 10^6 gal/h
    b. W = 7.2 x 10^6 gal/h x 8.3 lb/gal = 6.0 x 10^7 lb/h
    c. Q = 0.60 x 2.86 x 10^9 Btu/h = 1.72 x 10^9 Btu/h
    d. T = 1.72 x 10^9 Btu/h / (1 Btu/lb·F°) (6.0 x 10^7 lb/h) = 28.6 F°

16. a. Heat energy to mechanical energy in the turbine.
    b. Heat energy up the smokestack.

17. The steam is sent to the turbine at a lower temperature than in fossil fuel plants.

18. eff = (600 + 459) - 80 + 459) / (600 + 459) = 0.49 = 49%

19. Answers might include:

    a. Higher combustion temperatures. (This would call for new technology in combustion and in strengths and types of materials. High stack temperatures might add to thermal pollution. Higher combustion temperatures could create new chemical compounds which would be emitted by the stack.)

    b. Higher steam temperatures and pressures. (This might require new materials to withstand the additional stresses upon the boiler, steam lines and turbine blades. Additional heat carried away by the cooling water could add to thermal pollution.)

    c. Limit the transmission distances. (This would require more power plants which might add to our pollution problems. There may also be a minimum size for maximum efficiency of a power plant. There could be problems of supplying fuel to more plants because of a lack of transportation facilities.)

ENERGY CONSERVATION IN THE HOME

by

John Masonbrink
R. Doug Martin
Robert Starr

Recommended Level: Junior High Science or Social Studies

Time Required: Thirteen to fifteen class periods

Prepared for
the Nebraska Energy Office

Energy Conservation in the Home

1. Abstract: 1/4th of all energy used in the United States is consumed in our homes. Good conservation practices at home can extend our energy supplies and save us money. Energy can be saved by adding insulation to homes, by proper upkeep of homes and appliances, and by minor interior or exterior alterations.

2. Recommended Level: Jr. High

3. Time Required: 13 to 15 one-hour class periods

4. Teaching Strategies: include class discussion, individual research, lab activities, and problem solving.

5. Essential Advance Preparation: The teacher should read through the classroom activities of all of the three units before starting. This will enable all take-home and lab assignments to be prepared in advance.

Unit I - Units of Energy

GOAL: To understand the units of energy.

OBJECTIVIES:

1. Students will be able to read a utility meter and determine the amount of energy used.
2. Students will be able to define different units of energy.
3. Students will calculate the relationship between kilowatts and Btu's.
4. Students will calculate problems dealing with energy relationships.
5. Students will complete an energy survey.

CLASSROOM ACTIVITIES: Unit I

The teacher should alert the students to save their monthly electric bills as far in advance as possible.

On the first day of class, give the students the energy attitude survey (Activity 1). Tabulate the results, then review the questions letting the students elaborate on each. Next, show the students how to read an electrical meter and have them find the correct values shown on the meters in Activity 2. The first two activities can be done during a 1 hour class period. As soon as students learn to correctly read electrical meters, have them read their meter at home each day at the same time for one week. Each datum is to be recorded and will be used in Activity 2 of Unit II. Also, now is a good time to divide up the list of appliances in Activity 2, Unit II, so each student can begin monitoring about five appliances. This information will be needed for Activity 3 in Unit II.

Activity 3 will probably take one hour to complete if the apparatus is set up in advance. Be careful when setting this apparatus up. Use electrical tape over all exposed splices. The teacher should explain what quantity each meter is measuring and refer the students to the glossary for their definitions. At the end of the experiment the teacher should explain how the electrical power of the heater (voltage amps) used over a measured time period, is equal to the electrical energy used. Explain that the kilowatt-hour (KWH), and the Btu are both units of energy and that electrical meters keep track of energy used in kilowatt hours while many appliances (furnaces, air-conditioners, etc.) are rated in Btu's (British thermal units).

The next day the students can work the energy relationship problems for Activity 3, and the following day the teacher should review the terms listed in the glossary as well as review the answers for the energy relationship problems. Just before class is over, (10 - 15 min.) give the students Activity 4.

Unit 1 should take a total of about four to five one-hour class periods to complete.

ENERGY ATTITUDE TALLY

Question	Yes	Percent	No	Don't Know	Percent	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Find the percentages for each response. For example: if on Question one, 200 students responded; 100 say yes, 60 no, and 40 don't know, then the percent saying yes is 100/200 or 50%; saying "no" is 60/200 or 30%; saying don't know is 40/200 or 20%. Note that the total of the percent figures given should equal 100.

Activity _1_ : Energy Attitude Survey

1. Do you believe there is an energy shortage?

___yes ___no ___don't know

2. Do you believe you have been given a realistic picture of the energy situation facing the United States?

___yes ___no ___don't know

3. Do you believe most Americans are energy "wasters"?

___yes ___no ___don't know

4. Do you believe most Americans are energy "conservers"?

___yes ___no ___don't know

5. Do you believe it is the responsibility of every U.S. citizen to conserve energy voluntarily?

___yes ___no ___don't know

6. Do you believe Americans are "spoiled", self-indulgent and reluctant to take responsibility for the future?

___yes ___no ___don't know

7. Do you believe Americans will conserve energy only when government controls are imposed?

___yes ___no ___don't know

8. Would you be willing to reduce your standard of living to conserve energy?

___yes ___no ___don't know

9. Do you believe you as an individual can make an impact on energy consumption?

___yes ___no ___don't know

10. Would you conserve energy to save money?

___yes ___no ___don't know

11. Do you think the money saved is worth the inconvenience of conserving energy?

___yes ___no ___don't know

12. Do you feel technology will "bail us out" of the energy shortage?

___yes ___no ___don't know

13. Do you feel you have any imput or participation in the energy usage decisions made by your family?

___yes ___no ___don't know

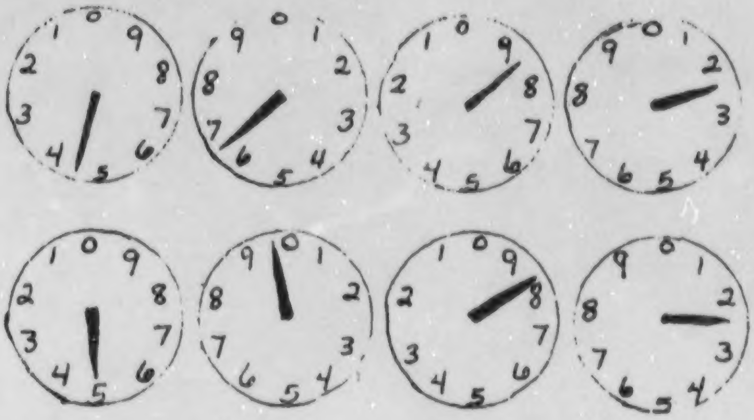
14. Are you going to do something to save energy?

___yes ___no ___don't know

Notes to Teachers for Activity 1.

You may want to extend the survey to the rest of the school including teachers and administrators. It could be interesting to compare student and adult opinions.

Activity 2 : Electrical Meter Reading



To read an electric meter, stand directly in front of the dials. Read dials from left to right. Some of the dials move in opposite directions from each other, but regardless of that, always read the smaller figure when the hands are between two numbers. For instance, in the upper set, the figures read 4682.

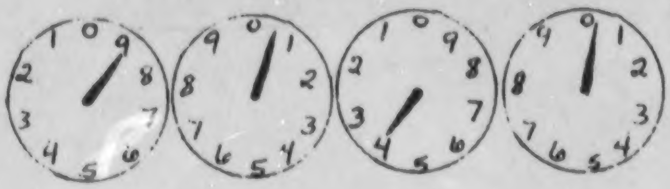
If the hand of the first dial appears to be directly over a number, read the next dial to determine whether or not the hand has passed zero. If it hasn't reached zero, use the next lower number on the first dial. The reading on the dials in the lower set should be 4982.

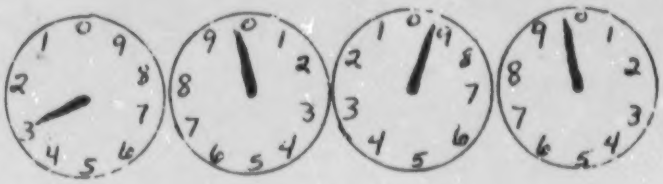
The figures on the dials on the next page, represent kilowatt hours (KWH) which signify the number of kilowatts flowing through your meter multiplied by the length of time, an hour.

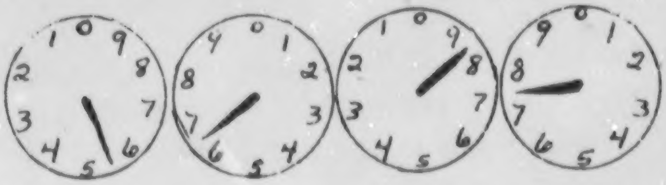
The answers to the problems on the next page are:

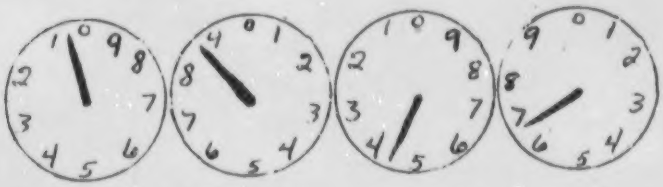
1. 9040 KWH
2. 2999 KWH
3. 5687 KWH
4. 0846 KWH
5. 2397 KWH
6. 3633 KWH

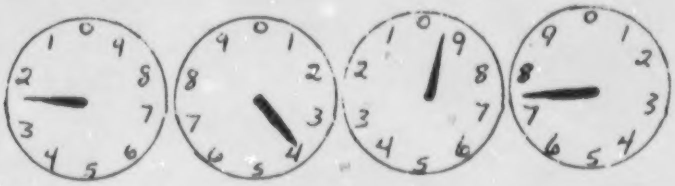
Activity 2:

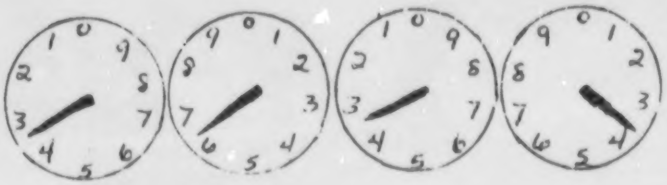
1.  ____________

2.  ____________

3.  ____________

4.  ____________

5.  ____________

6.  ____________

Activity 3 : Energy Relationships

The energy we use comes from many different sources and they are all related to each other. Therefore, when we waste or conserve one form, we, in a sense, are wasting or conserving all forms. For example, the person that saves electricity in reality is saving petroleum since petroleum is used in making electricity.

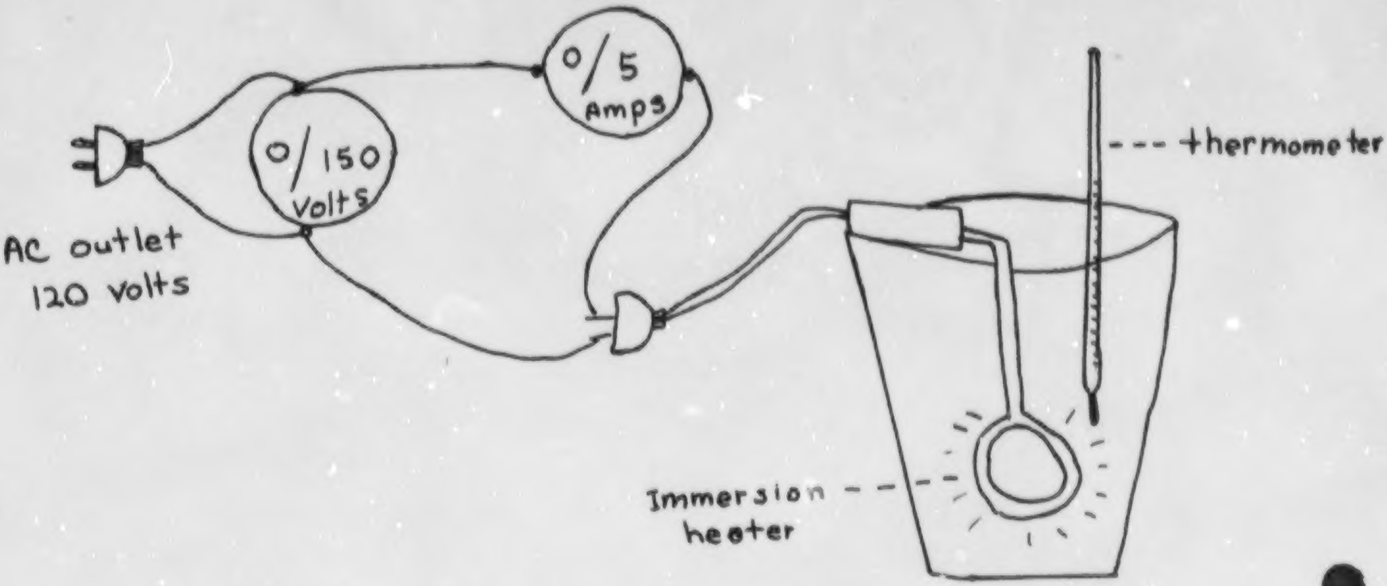
Most of the electricity produced in this country comes from heat. Enormous amounts of heat are used to produce steam, which in turn, causes a generator to make electricity. In this process 2/3 of the heat is lost and 1/3 is turned into electricity. Can you think of ways the lost heat might be made useful to man with his high energy needs?

The following experiment is designed so that you will acquire an understanding of the terms used to identify electrical energy and heat energy and how they are related to each other. By understanding these terms we hope that you may be able to better go about the task of conserving energy.

Activity 3:

Purpose: To determine the number of Btu's produced per kilowatt-hour of electricity.

Materials: 300 watt immersion heater (the kind used to make a cup of coffee), styrofoam cup, thermometer- °F, 250 ml gradulated cylinder, AC voltmeter (0-150 volts) AC ammeter (0-5 amp), 4 wires with battery clips.



Procedure: Wire up apparatus as shown in the diagram above (if voltmeter and ammeter are unavailable, they may be ommitted and use the watt rating of the heater).

1. Fill styrofoam cup with 227 ml of water (1/2 lb.) and record the initial temperature of the water.

2. Plug the heater into AC outlet for exactly 2 minutes.* Record volts, amps and final temperature.

Initial Temp. of H_2O T_i	Final Temp. of H_2O T_f	Amps	Volts	Time

*NOTE: Time may vary but the water must not be allowed to boil.

Calculations:

$$\boxed{\begin{array}{l}\text{No. of Btu}\\ \text{Acquired by}\\ \;\;H_2)\end{array}} = (T_f - T_i) \text{ X .5 lb. of water}$$

$$\begin{array}{l}\text{No. of KWH}\\ \;\;\;\text{Used}\end{array} = \frac{\text{Amps X Volts X hours}}{1000}$$

Example Results:

Volts	Amps	Initial Temp.	Final Temp.
125	2.8	60°F	136.5°F

Electrical Input = volts X amps = watts or KW

125v X 2.8a = 350w or .35KW

Since .35 kilowatts were used for 2 minutes or 1/30 hours,

then .35KW X 1/30 hrs. = .0116KWH.

The heat energy produced = .5 lb of water X (136.5 - 60) =

.5 X 76.5 = 38.25 Btu.

If it takes .0116 KWH to produce 38.25 Btu, then $\frac{.0116\text{KWH}}{.0116} = \frac{38.25\text{ Btu}}{.0116}$ or 1 KWH = 3293 Btu. This value compares favorably to the accepted value of 3412 Btu per KWH.

Problems for Activity 3 : Energy Relationships

Equations to be used in solution of problems are as follows:

watts = amps X volts

Btu - lbs of water X temp. change °

kilowatt = 1000 watts

kilowatt-hour = kilowatts X hours

NOTE: The answers are shown in parenthesis.

1. What is measured in amps? (electrical current)

2. The voltage of an ordinary electrical outlet is (120) volts.

3. How many Btu's are required to raise the temperature of 3 pounds of water 24 degrees F? (72)

4. How many watts of electrical energy are being used when an electrical current of 8 amps is flowing at a voltage of 120 volts? (960)

5. An electric iron rated at 1000 watts plugged into 120 volts uses how many amps of current? (8.33)

6. How many Btu's are required to heat 1 gallon of water from 60°F to 140°F? (Note - 1 gallon weights 8 lbs) (640)

7. If it takes 6 gallons of hot water to take a bath, how many Btu's are required? (See problem 6) (3840)

8. If the water in question 7 is heated with electricity at a rate of 4¢ for each kilowatt-hour, what does it cost to heat the water? (3412 Btu in a KWH) (4.5¢)

9. A teakettle with 3/4 of a gallon of water is heated on an electric stove from 60° to 210°F needs how many Btu of heat? (900)

10. How many KWH of electricity is required to heat 12 teakettles full? (3.16)

11. At 4¢ for each KWH, what is the cost of heating the 12 teakettles of water? (12.64¢)

12. When natural gas is burned, 900 Btu's of heat are produced for each cubic foot of gas. How many cubic feet of gas would be needed to heat 1 teakettle of water? (1)

13. How many cubic feet of gas are needed for 12 teakettles of water? (12)

14. Gas costs 25¢ for 100 cubic feet. What is the cost to heat the 12 teakettles of water? (3¢)

15. Is it less expensive to use gas or electricity to heat water? Explain.

Activity __4__:

Introduce the students to the terms defined in the glossary. The following test may be given after Unit 1 is completed to measure the understanding of these terms.

ANSWERS TO TEST:

1. B
2. D
3. A
4. D
5. D
6. B
7. B
8. B
9. A
10. B
11. C

TEST UNIT 1

Circle the answer which best completes each sentence.

ENERGY TERMS:

1. Energy due to motion is called: (A) electrical energy, (B) kinetic energy (C) potential energy (D) motion energy.

2. Electrical current is measured in: (A) volts (B) ohms (C) degrees Celsius (D) amperes.

3. Heat transfer through a solid is called: (A) conduction (B) convection (C) radiation (D) insulation

4. Natural gas is mainly composed of: (A) hydrogen gas (B) propane (C) butane (D) methane

5. The effectiveness of an insulator is determined by: (A) its thickness (B) its strength (C) its conduction coefficient (D) its R-value

6. The force moving a quantity of electricity is measured in: (A) ohms (B) volts (C) amperes (D) watts

7. Energy due to the position of one body with respect to another or relative parts of the same body is called: (A) kinetic energy (B) potential energy (C) radiant energy (D) position energy

8. Heat energy moved by currents is called: (A) conduction (B) convection (C) radiation (D) ampere

9. Electrical energy is measured in: (A) kilowatt-hours (B) volts (C) amperes (D) calories

10. Heat energy is measured in: (A) kilowatt-hours (B) Btu (C) degrees Celsius (D) watts

11. Heat transfer through space is called: (A) conduction (B) convection (C) radiation (D) insulation

Unit II - Electrical and Gas Usage in the Home

GOAL: To conserve electrical and gas energy in the home.

OBJECTIVIES:

1. Determine the amount of electrical and gas usage in the home.
2. Determine the best method of energy conservation in the home.

Unit II should take a total of about 5 one-hour class periods to complete.

The students should already be monitoring appliances and electrical meters at home as identified earlier. This information will be needed during this unit. The first day of class the teacher should give the students Activity 1, "Home Energy Checklist". The teacher should review over the questions with the students during class, and the students should fill out the checklist that evening at home. Make sure the students know how to answer each question before they go home. To answer question 19, the students will have to measure each window's length and width to find the area (A = L x W) in square inches. They will then need to add the areas of the windows together for a total window area. Change the total window area to square feet (1 sq. in. = 1/144 sq. ft.). Next the student must find the square footage of the house above ground level. To find this the student will need to draw a floor plan of the exterior of the house, listing the length, in feet, of each exterior wall. Divide this total window area by the area of the house to see if the window area is 10 percent or less (.1 or less).

The next class period, the students should tabulate their Home Energy Checklist, and the teacher should explain why each item is important in conserving energy.

The third class period should be spent doing Activity 2. The teacher may do any or all of the activities listed in Activity 2. The information for number 3 should be about ready to graph. The teacher may decide to make up some more problems dealing with energy requirements of various appliances.

The fourth class period can be spent doing Activity 3. The students may already have time cards completed on their appliances so all they need to do is determine its wattage and cost of operation.

The last class period of Unit II should be spent by asking the students to write a paragraph or two explaining how they could best save energy in their own home. Also time can be given to discus and compare energy use in cooking appliances and appliance efficiency standards. This information is supplied in Appendix C.

ACTIVITY 1 : Home Energy Checklist

Use the following checklist to find home energy waste and possibilities for conservation. Answer each item yes or no.

House: The Shell

1. Are plants properly located around the house to provide a break against wind and shade against unwanted sun?
2. Are drapes and furniture located so they do not obstruct heating, air-conditioning or ventilation?
3. Are draperies insulated?
4. Do draperies fit snugly around the window?
5. Are exterior house doors closed quickly after use?
6. Are lights and appliances turned off after use?
7. Do you have storm windows and doors?
8. Are all doors and windows properly caulked and weather-stripped?
9. Are draperies and shades closed at night and on cloudy, windy days during the heating season?
10. Are draperies opened to admit sunlight on sunny days in the heating season?
11. Are draperies and shades closed on sunny days during the cooling season?
12. Is the attic ventilated?
13. Is the attic insulated 6 - 8 inches?
14. Are the walls insulated?
15. Do floors exposed to unheated or cooled air have from 2 - 3 1/2 inches of insulation?
16. Is the fireplace damper closed when not in use?
17. Is the den, gameroom or family room oriented to the south?
18. Is the house shaded from the western sun?
19. Does your home have window area equivalent to 10 percent or less of its square footage?
20. Is your home sealed from drafts? Is it free from cracks and holes?

21. Does your home have fluorescent lighting where appropriate?

22. Does your home have wall-to-wall carpeting?

23. Do all windows have drapery, shades, blinds, shutters or other coverings?

Environmental Control

24. Are ducts, radiators or air-conditioners closed off in unused rooms or closets?

25. Are hot water pipes insulated in unheated and uncooled spaces?

26 Are air ducts insulated in unheated and uncooled spaces?

27. Is the thermostat set at 68°F or below during the heating season?

28. Is the thermostat set at 78°F or above during the cooling season?

29. Are heating and cooling filters clean?

30. Are windows and doors tightly closed while mechanically heating or cooling?

31. Is the thermostat turned back at night?

32. Is an attic fan used in the summer?

33. Do thermostats indicate correct temperature settings?

34. Is an outside air-conditioning unit located on the shady (north) side of the house?

35. Is the water heater insulated?

36. Is the water heater temperature setting at 140°F or less?

37. Is the air-conditioning unit properly sized for your needs?

38. Do you have a heat pump?

39. Do you use natural ventilation as much as possible?

40. Are radiators and other heating or cooling equipment clean and dust free?

41. Is the water heater located in a heated space?

Housing Selection

42. If you live in an apartment, is it an "inside apartment?

43. If you live in a mobile home, does it have a "skirt"?

44. If you live in an older home, have its plumbing, wiring, insulation and chimneys been checked by "experts"?

Food

45. Is the frost on the refrigerator and freezer less than 1/4 inch thick?

46. Is the refrigerator set at 40°F?

47. Is the freezer set at 10°F?

48. Are gaskets around refrigerators and freezers tight?

49. Is the oven used to bake more than one food at a time?

50. Is the gasket around ovens tight?

51. Are frozen foods thawed completely before cooking?

52. Is the cooking range turned off immediately after use?

53. Are dishes washed only when there is a full load?

54. Are dishes allowed to air dry?

55. Are appliances clean and dust free (particularly cooling coils)?

56. Is the oven never used as a dryer or heater?

57. Are flat bottom pots and pans used?

58. Is a timer used to avoid over-cooking?

59. Are pots covered during cooking?

60. Is as little water used as possible during cooking?

61. Is the heated dry cycle on the dishwasher not used?

Clothing

62. Does your family dress warmer in cool weather to avoid mechanical heating?

63. Does your family dress cooler in warm weather to avoid mechanical cooling?

64. Are clothes washed only when there is a full load?

65. When washing is cold or warm water used when possible?

66. Are clothes line dried when possible?

67. Are most of your family's clothes wash-and-wear, permanent press to avoid dry cleaning and ironing?

68. Are clothes always rinsed with cold water?

69. Is the washer located near the water heater?

70. Is the dryer lint screen cleaned after each load?

Personal Care

71. Do the members of your family take short showers or use only small amounts of water for tub baths?

72. Are all water faucets repaired and not leaking?

73. For washing, shaving or make-up, is the lavatory filled rather than allowing water to run?

Entertainment

74. Are entertainment devices turned off when not in use?

75. Do members of your family try to entertain themselves rather than rely on devices?

If you answered with 65 or more "yes's", you are truly an energy conserver and will make a good conservation advocate.

If you answered with 55 to 65 "yes's", you are energy conscious but lack will-power or drive.

If you answered with 45 to 54 "yes's", you are wasting energy but with minor changes could make a conserver.

If you answered with 35 to 44 "yes's", you are an energy waster and should make an all-out effort to reform!

If you answered with less than 35 "yes's", you are making an effort to waste energy and should consider the long range and immediate effects!!

Notes to Teachers for Activity 1 .

1. You might want to distribute these check lists school wide,
2. Try a before and after approach to using the checklist. Check before your conserving effort and after.
3. Survey students to see if their families are generally conservative or not.

Note to teachers for Activity 2 .

It would probably be a good idea to alert students about the use of the electric bills sometime in advance of this activity.

Activity 2 : Appliance Energy Audit

In this activity you will need to refer to the glossary (Appendix A), and know the definitions for watt, kilowatt, and kilowatt-hour. From an electric company bill, determine the average cost of a kilowatt-hour (KWH) for your area. If this is not available, contact the electric company to find what the average cost of a kilowatt-hour is.

Use this value and data from the "Average Wattage of Electrical Appliances", on the next page, to compute the energy requirements for the following situations:

1. Leave a 100-watt light bulb burning for 6 hours.
2. Use a vacuum cleaner for 2 hours
3. Use all burners of the oven and range for 3 hours.
4. Use a dishwasher for 1 hour every day for 30 days.
5. Run an electric clock for one year.

On a separate sheet of paper, make a list of all the electrical appliances in your home. What appliances consume the most energy? Which ones consume the least? Are these appliances necessary or simply luxuries? What can we do to conserve energy and decrease household costs?

Activities to Complete at Home

1. Check the wattage of the light bulbs and fluorescent bulbs in your house, and estimate the number of minutes or hours that they are used each day. Determine the cost of lighting your home for one day, one month, and one year.

2. If previous electric bills are available, construct a graph to show the monthly cost of electricity consumed in your home over the past 12 months. Is there a significant variation in the cost per month? Which months are most expensive? Why?

3. Record the reading on your electric meter at the same time each day for 1 week. Plot a cumulative graph to illustrate your energy consumption for this period of time. Is more electricity consumed on some days than others? Why?

AVERAGE WATTAGE OF ELECTRICAL APPLIANCES

1000 watts = 1 kilowatt

Appliance	Average Wattage	Appliance	Average Wattage
Bottle Warmer	400	Heat Lamp (Infrared)	250
Broiler	1325	Heater, Radiant	1095
Clothes Dryer	4600	Hot Plate	1140
Clock	2	Mixer, Food	130
Coffeemaker (Automatic)	830	Oil Burner	245
Cooker (Egg)	520	Percolator	490
Dehumidifier	230	Radio	90
Dishwasher (with heat unit)	1155	Radio-Ohonograph	100
Dishwasher (no heat unit)	290	Razor	15
Disposal (only)	330	Sewing Machine	75
Fan, attic	370	Stoker	300
Fan, desk	70	Television	280
Fan, ventilating	85	Toaster	1000
Fan, furnace	225	Vacuum Cleaner (tank type)	375
Floor polisher	240	Vibrator	45
Germicidal Lamp	20	Waffle Iron	855
Grill	770	Washer	280
Hair Dryer	235	Water Pump	265

These appliances are usually controlled by thermostats which permit the flow of electricity for intermittent periods of time only.

Electric Blanket	180	Range	12,000*
Heating Pad	55	Refrigerator	205
Food Freezer (8 cu. ft.)	125	Room Cooler (Window Type)	400
Iron	1,000	Roaster	1,300
Ironer	1,500	Water Heater (66 gallons)	3,250

* This includes total wattage of all the burners and oven of the range.

Activity 3 : Energy Consumption of Appliances

Choose five home appliances that can be monitored for one week. Locate the serial plate and find the wattage listed for each appliance and record this information. The wattage is an indicator of the kilowatt-hours of energy used per hour of operation of the appliance. It requires 1 kilowatt-hour per hour of operation for 1000 watts.

EXAMPLE: An appliance is rated at 960 watts.

$$960 \text{ watts} \div 1000 \frac{\text{watts}}{\text{kilowatt-hr. per hr. of operation.}} = .96 \text{ kilowatt-hour}$$

Record the hours of use per day for each of the experiment's test appliances. An easy way to keep track of time would be to attach an indix card to each appliance so that any member of the family can record the amount of use time. While collecting the data, calculate the KWH (wattage X use time) used per day for each appliance.

Using the average cost per KWH found in activity 2, determine the cost of operation for each of the appliances by multiplying the KWH by the cost per KWH.

EXAMPLE: A styling hair dryer uses 330 watts and its "on" time is 4 hours per month. How many KWH's are used, and what does it cost to operate if the cost per KWH is $0.038?

$$\text{KWH} = \frac{\text{wattage X hours}}{1000 \text{ watts}} = \frac{330 \text{ X } 4}{1000} = \frac{1320}{1000} = 1.32 \text{ KWH}$$

$$\text{Cost of Operation} = \text{KWH} \times \text{Cost per KWH} = 1.32 \times \$0.038 = \$0.05016 = \$0.05$$

Take the number of KWH used and calculate, by multiplying, the number of KWH that might be used in a month; in a year.

Using your last month's electric bill (total KWH's used), determine what percentage of electrical power was required to operate the appliances.

Notes to teachers for Activity 3.

1. Caution students not to attempt to move large appliances by themselves to find the wattage ratings.
2. Students should seek permission and aid from parents to locate wattage rating information
3. The teacher can use appliances from home economics as examples to save time.
4. Students may be assigned different equipment to insure a wide range and complete investigation of household appliances.
5. Answers in terms of kilowatt-hours of energy required may be expanded to annual use by determining daily and/or weekly use by multiplying by 365 days and/or 52 weeks respectively.

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Unit III - Heat Movement (Infiltration)

GOAL: To keep heat from escaping in the winter or entering in the summer.

OBJECTIVES:

1. By performing a cooling curve experiment the student can determine why thermostat settings can save energy.
2. Students will determine if infiltration can be slowed or stopped by checking insulation and weatherproofing.
3. Students will find the R-values of different materials.

Unit III should take a total of about 4 to 5 one-hour periods.

CLASSROOM ACTIVITIES:

Begin this unit by completing the cooling curve experiment, Activity 1, and answering the accompanying questions. If the teacher has all students perform the actual experiment, this will take most of one class period, and the next period, the following day, can be spent answering the questions. If the teacher only duplicates the results provided, the questions can be answered while the students observe the data; taking up only one class period.

Activity 2 can be given to the students at the end of the first or second class period, and the students can perform this at thome. If enough thermometers aren't available, the teacher may wish to have several students living close together use the same two thermometers. Before the students do Activity 2, the teacher should explain what to check for and where to look when examining the caulking, putty and weatherstripping.

The second or third class period should be spent discussing the results of Activity 2 and displaying Activity 3. The teacher should point out the advantages and disadvantages of different types of insulation.

The next class period can be spent doing Activity 4, a field trip to a house under construction or recently completed. The teacher should point out the types of insulation used, and the students should compute the R-value for walls, ceiling, and floors. Also the windows and doors should be checked for caulking, putty, weatherstripping, and number of glazings.

The last class period should be spent summarizing all that has been studied.

Activity 1 : Cooling Curve

PURPOSE: To determine the effect of cutting back the thermostat to the savings of heat energy.

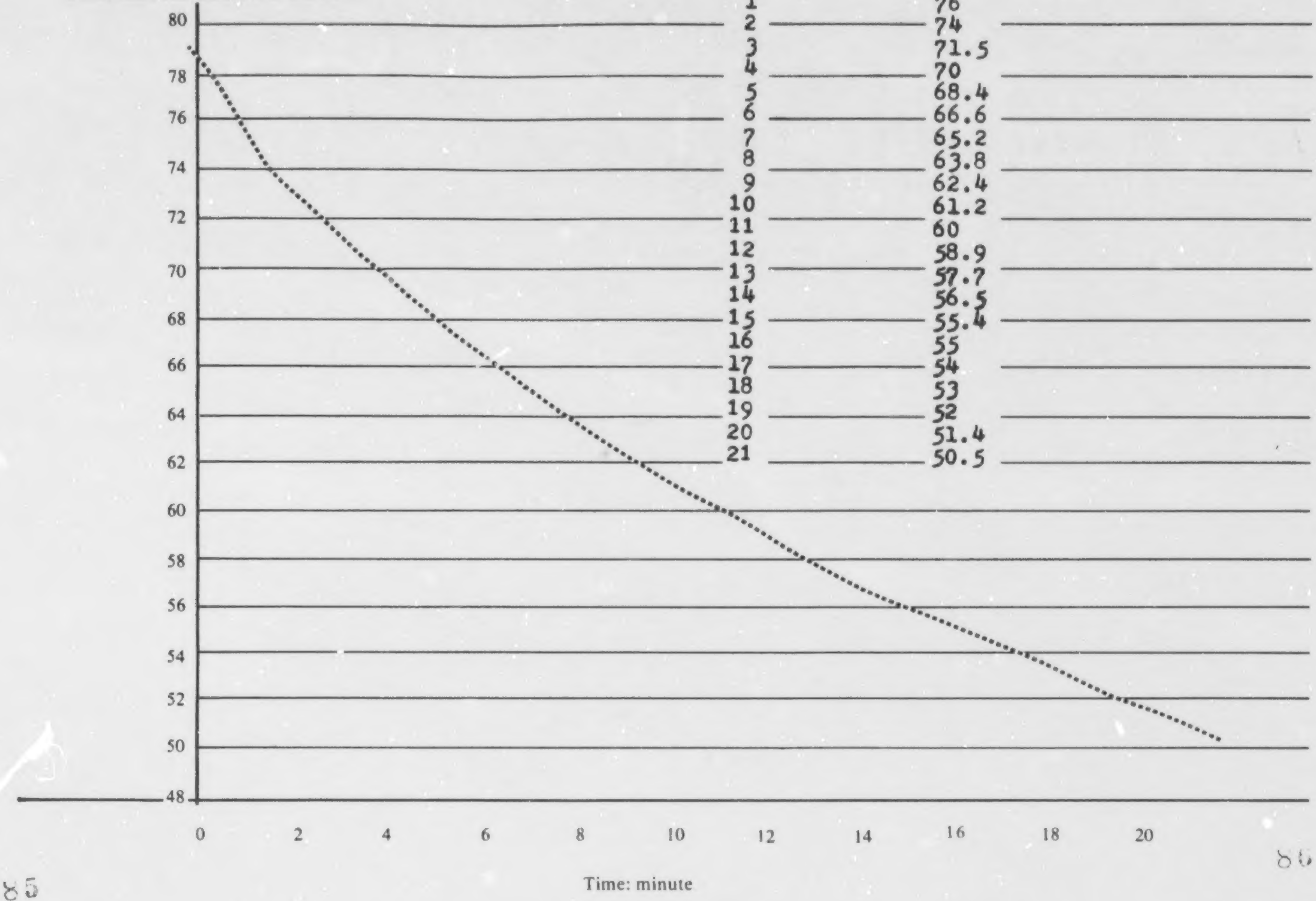
PROCEDURE: Fill a baby food jar 4/5 full of water with a temperature of approximately 180°F and let this cool for 20 minutes taking the temperature every minute. Plot a graph of the results putting the temperature on the vertical axis and the time on the horizontal axis. NOTE: Label each axis with a proper title.

NOTE: Heat and temperature are not the same. Heat is measured in Btu's. A Btu is calculated by (pounds of H_2O x Degrees Fahrenheit of temperature change). Temperature is measured in °F . However, since the amount of water stays the same the amount of heat is directly proportional to the temperature.

PROBLEMS: Using the cooling curve provided, answer the following questions.

1. How long in minutes does it take to cool 4°C at:
   a) 58°C
   b) 80°C
2. Which cools faster , cold or hot water? Explain.
3. Since the cooling curves of things that cool are all similar this curve could represent how your house cools. Explain why you would save more energy by cutting back your thermostat from 72° to 68°C.
4. If you were to insulate how would that change how fast your home would cool off?

This was made using Celsius thermometer instead of Fahrenheit but the curve is the same.



Data

Time(min)	Temp (celsius)
0	79
1	76
2	74
3	71.5
4	70
5	68.4
6	66.6
7	65.2
8	63.8
9	62.4
10	61.2
11	60
12	58.9
13	57.7
14	56.5
15	55.4
16	55
17	54
18	53
19	52
20	51.4
21	50.5

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Activity 2 : Wall Insulation and Weatherproofing Investigation

During the heating or cooling season, when the heating or cooling equipment is operating, place a thermometer firmly against the inside surface of an exterior wall and another in the center of the room. It's easiest to hang the thermometer on a picture nail or hook on the wall and place it in a chair in the middle of the room. Allow sufficient time for the temperatures to register and then record the two readings. If the difference between the two readings is greater than 5°F, the wall is probably not adequately insulated.

Try this in several rooms with exterior walls.

Room ____________________

Outside wall thermometer reading _____________

Center of the room thermometer reading ________

The difference between the readings:

______________ - ______________ = ______________

(higher reading) (lower reading) (difference)

Is the difference greater than 5°F?_______________

Conclusions:

Are there reasons other than inadequate wall insulation which might cause a difference in the temperature readings? ________________, What might they be?

To reduce the heating and cooling costs in a home, it is important to reduce air movement in or out of the home. The cheapest and most effective way to reduce infiltration is weatherproofing: caulking, putty, or weatherstrips. Use the checklist to determine the condition or existence of weatherproofing at your house.

1. Windows:

___ Good - Good, unbroken weatherstripping in all places with no drafts.

___ Fair - Weatherstripping damaged or missing in some places and minor drafts.

___ Poor - No weatherstripping at all and very drafty.

Conclusions:

2. Doors:

___ Good - Good, unbroken weatherstripping with no drafts.

___ Fair - Weatherstripping is missing or damaged in places with minor drafts.

___ Poor - No weatherstripping and very drafty.

Conclusions:

3. Area around the doors and windows:

___ Good - Caulking fills all cracks around the door frame and the putty around the window is unbroken and solid; no drafts.

___ Fair - Putty and caulking are cracked or missing, causing minor drafts.

___ Poor - No caulking at all and the putty is in very poor condition causing very bad drafts.

Conclusion:

If you checked fair or poor for any of the three areas, then the weatherstripping, caulking, or putty needs to be replaced. If all areas are good, then you probably don't need caulking, weatherstripping, or putty this year.

Activity 3 : Insulation Investigation

There is a wide variety of insulation available today. Each has different uses, R-values, and forms. As a class, try to collect five to ten different types of insulation and develop an information display indicating the R-values and uses of each. Try to obtain the following types:

1. Loose-fill mineral wool,
2. loose-fill polystyrene beads,
3. batt mineral wool without vapor barrier,
4. batt mineral wool with vapor barrier,
5. rigid foam board,
6. cellulose fiber,
7. vermiculite or perlite.

Look on the label for the R-value and use.

Notes to teachers on Acitivity 3 .

1. Seek insulation from building supply stores, building contractors, and insulation suppliers.

2. Your local utility company may have an insulation display and demonstration which they would present at your school.

3. Be careful with fiberglass insulation -- it is glass and can penetrate the skin causing a great deal of irritation.

Activity 4 : Field Trip to house under construction.

The teacher should arrange a field trip to a house under construction or one recently constructed. Using this information provided, determine the R-value of walls, windows, ceilings, and floors. Also note the caulking, puttying and weatherstripping. Discuss concerns of insulation with the contractor.

Insulation

TYPES: Loose fill, Batte or Blanket, Foamed in place.

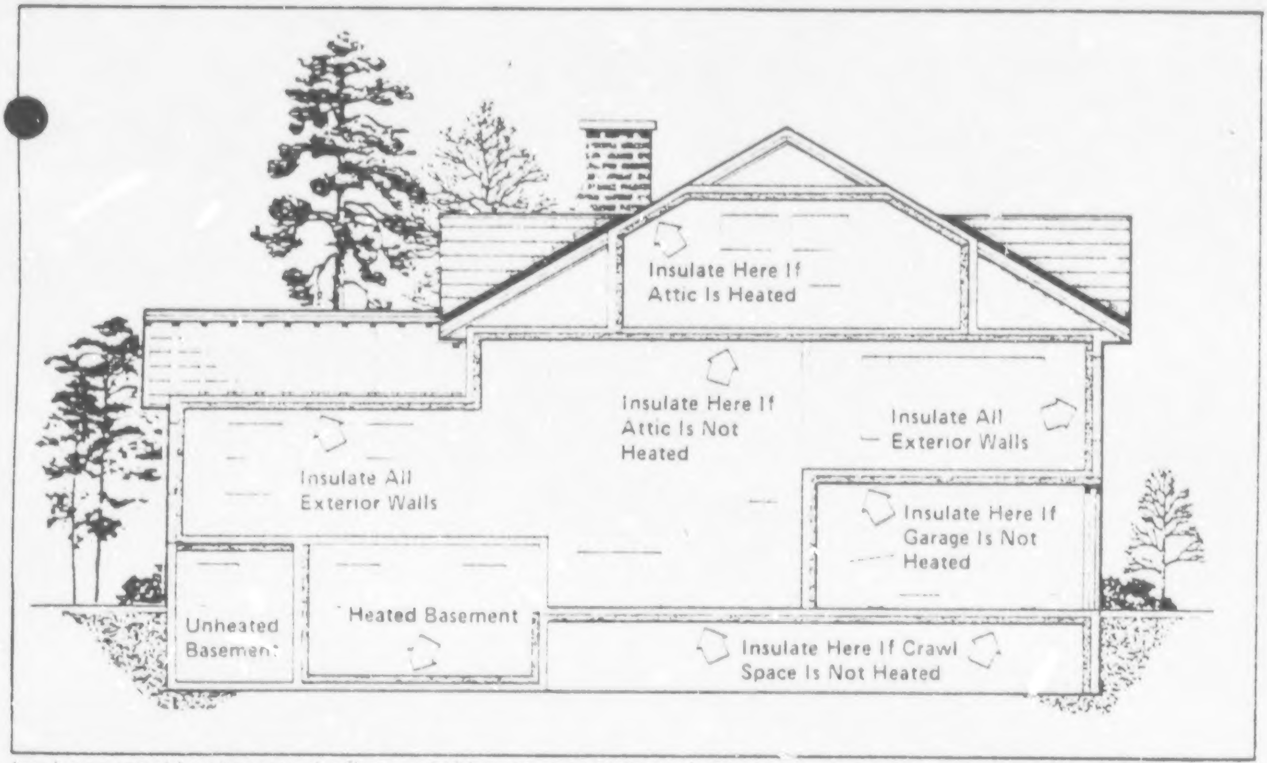
KINDS: Cellulose, Glass Fiber, Mineral Wool, Vermiculite, Rigid Board, Bead Board, Urea Formaldahyde

R-VALUES: (Resistance to heat flow)
(per inch)

Cellulose	R = 3.67
Glass Fiber	R = 3.14
Mineral Wool	R = 3.33
Vermiculite	R = 2.08
Beadboard	R = 3.5-40
Urea Formaldahyde	R = 4.1 - 4.8
Brick	.20

Recommended R-Values

Ceiling	R = 25-35
Walls	R = 16-22
Floors	R = 13-19


Insulate Here If
Attic Is Heated
Insulate Here If
Attic Is Not
Heated
Insulate All
Exterior Walls
Insulate All
Exterior Walls
Insulate Here If
Garage Is Not
Heated
Unheated
Basement
Heated Basement
Insulate Here If Crawl
Space Is Not Heated

Insulation should go between the floor and either the unheated crawl space or basement, between the ceiling and unheated attic (between the attic and the roof if the attic is heated), and inside all exterior walls (including those adjacent to an unheated garage).

INSULATING PRODUCTS AT A GLANCE

Information from the Texas Agricultural Extension Service, 1978

PRODUCT	COMPOSITION	FIRE SAFETY	MOISTURE RESISTANCE	ODOR	RODENT & VERMIN RESISTANCE	CORROSIVENESS	APPROXIMATE R VALUE PER INCH	INSTALLATION FORMS
Cellulose	Vegetable and Wood Fibers	Safety questionable if untreated with flame retardant chemicals. Fire retardant chemicals can leach out or turn to a gas.	Readily absorbs moisture which may affect flame retardant chemicals and may cause compacting and facilitate fungi growth.	Generally none	Some may contain starch and attract rodent and vermin. Needs Boric Acid or Borax to create resistance.	Noncorrosive. Flame retardant chemicals may be.	3.6	Spray on Pour in Blow in Blanket
Mineral Wool	Rock Slag, or Glass	Will not burn Paper moisture or vapor barrier may burn.	Collects on surface of fibers; but when dry, R value is regained.	None	Does not attract nor deter.	Noncorrosive	Batts and Blankets = 3.5 - 3.75 Loose Fill = 2 - 3	Batts Blankets Rigid Board Blow in Pour in
Urea Formaldehyde	Urea, Formaldehyde, and a catalyst	Resists spread of flame, tends to shrivel and char.	Absorbs moisture but dries to original condition.	Some during curing and after curing if absorbs moisture	Does not attract nor deter. Is resistant to common molds and is mildly bactericidal.	Noncorrosive	4 - 4.5	Foamed in Place
Extruded Polystyrene bead and Urethane Board	Plastics: Polystyrene Urethane	Combustible Must be covered with ½" gypsum board or equivalent.	May absorb moisture but dries to original condition.	None	Does not attract nore deter.	Noncorrosive	Varies up to 5.4	Rigid Boards

FACTS ABOUT HEAT AND COLD TO HELP FURNISH YOUR HOME FOR WINTER

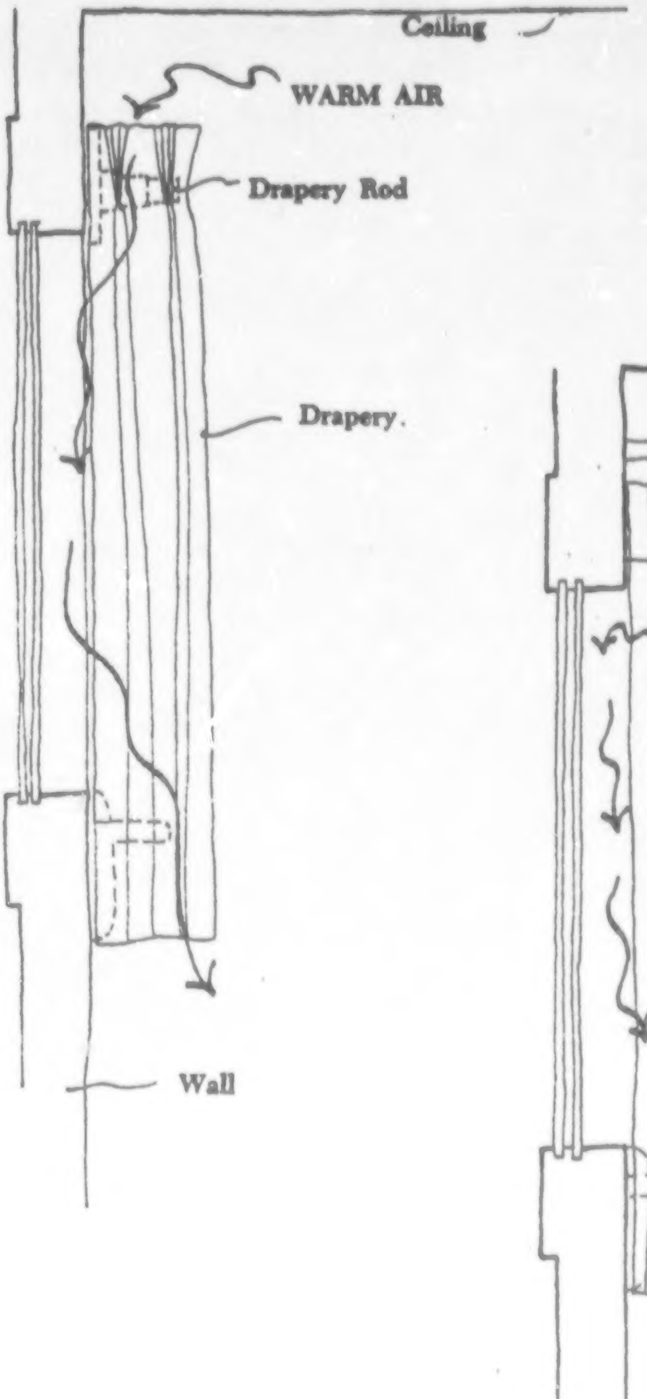
FACT	ENERGY SAVERS (add your own ideas)
1. Warm air moves toward cold air.	Close off unheated areas of the house by shutting doors, hanging fabric over openings.
2. Windows are a major source of heat loss, particularly on non-sunny sides of house at night.	Draw down shades at night if you have them. Add insulating lining material to draw draperies if you have them, and close draperies at night. If you have neither, consider installing one or the other.
3. Window glass is a poor insulator and allows both heat and cold to pass through it readily.	Plan winter window treatments that give added insulation. In little used areas, consider sheets of one inch thick styrofoam cut so they friction fit.
4. Uncovered windows, when glass is cold rob warm air from room and your body if you are next to them.	Plan window coverings of some sort. When possible, re-arrange furniture so that seating is not near windows.
5. Windows are a good source of "solar heat" on the sunny sides of houses.	Open draperies or curtains to take advantage of the sun's warmth. Close off rest of house. Turn down thermostate and use "solar heated" rooms during sunny hours.
6. The greater the difference in temperature, the faster warm air moves toward cold.	Locate and cover "cold spots" around doors, windows. Cover cold walls with a quilt or coverlet that enhances the furnishings.
7. The colder the glass in uncovered windows, the faster the warm air is robbed.	In addition to suggestions already made, consider adding plastic sheeting on the inside of "problem" windows.
8. Trapped air (air cells) offers good insulation.	A thermal blanket is warm when a cover is placed on top. Thick pil carpets reduce heat loss. "Fuzzy" or napped fabrics are warmer.
9. Air infiltration causes drafts. The colder the air, the greater the drafts around doors, windows, etc.	You can use small folded rugs against doors to stave off drafts. Even better, make some "draft dodgers"--fabric tubes containing sand that can be fitted against doors and window sills.
10. Open fireplace dampers let chimney flues draw warm air up out of room.	Check fireplace for damper. If one exists, keep it closed. If none, install a damper, or cover the fireplace opening. A removeable damper can be improvised with angle irons screwed to the brick at top front of fireplace. A mason can do this. A board cut to fit opening can rest on angles and be removed when fireplace is in use.

Single Glazed - R = .88
Double Glazed - R = 1.72
Triple Glazed - R = 2.78

Double Glazed, loose drapery = 1.90

Double Glazed with closed top cornice & pull shade R = 2.05

Double Glazed with pull shade, closed top cornice, & sealed drapery, R = 2.35


Ceiling
WARM AIR
Drapery Rod
Drapery.
Wall

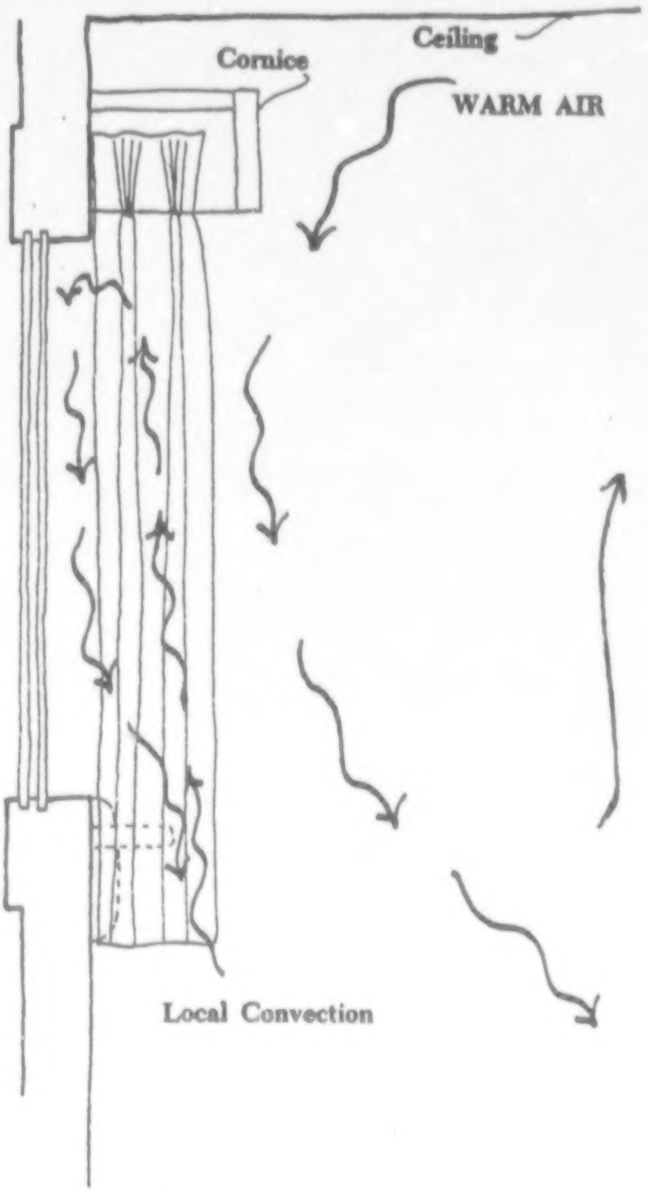

Ceiling
Cornice
WARM AIR
Local Convection

Fig. 1 - Tightly fitted interior treatments stop movement of heated air through window space.

APPENDIX A

GLOSSARY

Amp. measure of the rate of energy flow through a conductor.

British Thermal Unit (BTU). The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at, or near, its point of maximum density (39.1°F).

Calorie. The amount of heat necessary to raise one gram of water at 15°C, 1°C. The National Bureau of Standards defines the calorie as 4.18400 joules. (1 BTU is equivalent to 1055 joules.)

Celsius Scale. The temperature scale using the ice point as 0 and the steam point as 100, with 100 equal divisions or degrees between; also known as the Centigrade Scale.

Current (Electric). The rate of transfer of electricity.

Electrical Energy. The energy associated with electric charges and their movements. Measured in watt hours and kilowatt hours. One watt-hour equals 860 calories.

Energy. The capability of doing work. Potential energy is energy due to position of one body with respect to another or relative parts of the same body. Kinetic energy is due to motion.

Heat. Energy possessed by a substance in the form of kinetic energy, usually measured in calories or, in space heating, by the British thermal unit. Heat is transmitted by conduction, convection, or radiation.

Heat Transfer.

1. Conduction. Heat moves from hot solid material to cold solid material.
2. Convection. Heat moving through air currents.
3. Radiation. Heat energy moving through space such as from the sun to the earth.

Insulation. A substance that insulates is one that can slow down the flow of heat or sound.

Kilowatt (KW). The unit of power equal to 1,000 watts, 3.413 Btu's, or 1,341 horsepower. Roughly a power of one kw is capable of raising the temperature of a pound (pint) of water 1°F in one second.

Kilowatt-Hour (KWH). The amount of work or energy delivered during the steady consumption of one kilowatt of power for a period of one hour; equivalent to 3.412 Btu's.

Natural Gas. Naturally-occuring mixtures of hydrocarbon gases, mostly methane, and vapors occurring naturally in certain geologic formation; usually found associated with oil.

R-Value. Thermal resistance; computed by the conductivity divided into one. The measure of resistance to heat flow.

Voltage. The amount of force employed to move a quantity of electricity; measured in volts.

Infiltration. Heat movement from an area of high concentration to an area of low concentration.

APPENDIX B

Additional activities--may be used to supplement or replace other activities

Films

1. Saving Home Energy - (22 min) by Nebraska Energy Office Energy development in Nebraska from 1974 to present. Show weatherization needs of a typical older and newer home.
2. All About Insulation - (15 min) by Owens/Corning Information about R-value and vapor barriers Mostly "how to" install batt insulation in various locations of a home.
3. Project Conserve - South Dakota Residential Home Energy- (20 min) by FEA and Brookings, South Dakota Information on furnace inspection and other energy savings ideas in the home.
4. Cap in the Gap - (25 min) by FEA (used mainly by Community Action Agencies) "How to do" information on weatherization such as installing polyethylene covers over windows, weatherstripping, caulking, and insulating a home.

Brochures (Obtainable in class size quantities from Gary Lay, Education Coordinator, Nebraska Energy Office, Lincoln, Nebraska 68509)

1. How to Save Money by Insulating Your Home
2. Energy Conservation with Windows
3. Tips for Energy Savers
4. 65 Ways to Save Natural Gas
5. Home Energy Saver's Workbook
6. Energy Savings Through Automatic Thermostat Controls

Resources:

Energy Activities for the Classroom
Herbert L. Coon and Michele Y. Alexander
ERIC Center for Science, Mathematics, and Environmental Education
College of Education
The Ohio State University
1200 Chambers Road, Third Floor
Columbus, Ohio 43212

Energy Conservation in the Home
Curriculum Guide for Home Economics Teachers
University of Tennessee Environment Center and College of Home Economics
Knoxville, Tennessee

APPENDIX C

APPLIANCE EFFICIENCY STANDARDS

Did you know that when you buy a $200 air conditioner your local electric utility may have to spend $1000 or more to provide the capacity to operate the unit?

Did you know that an inefficient air conditioner that costs $100 less than an efficient unit of the same size may cost you $500 more in your electric bills over a ten year period?

Did you know that if Iowans over the next ten years bought reasonably efficient air conditioners, refrigerators, and freezers rather than units of typical efficiencies, the state could avoid building one large electric power plant? This would be one large plant that would never have to be built.

The Energy Policy Council has recommended that the state establish energy efficiency standards for air conditioners, banning the sale of inefficient units. This would have many positive effects:

- Consumers would buy only efficient models and save hundreds of dollars over the lifetime of the appliance, even if energy prices remain constant.
- The state's electric power capacity requirements would be lowered, saving utilities hundreds of millions of dollars in capital costs, capital that would be freed for other useful purposes.
- The state would save substantial amounts of energy, meaning less coal or nuclear fuel consumption.

Here are some sample calculations of the savings possible. Try them out yourself using the slide rule found on the center pages of this bulletin.

One manufacturer sells two 14,000 Btu/hour air conditioners. One has a high efficiency (EER = 10.1) and draws only 1380 watts at standard conditions; it costs about $400. The other has a low efficiency (EER = 5.1) and draws 2760 watts; it costs about $280. Over a ten-year period, if the unit runs 1000 hours a summer and electricity costs 4¢ per kilowatt-hour (the current average price in Iowa), the high-efficiency unit will cost a total of $950 (counting the $400 selling price), while the low-efficiency unit will cost $1380. The model that is $120 cheaper actually costs $430 more over ten years!

One manufacturer sells two 17 cubic-foot no-defrost refrigerator freezers that look alike. The model sold most frequently costs $430 and requires 154 kilowatt-hours of electricity a month under the typical operating conditions of the test procedures. Another model costs $480 but requires only 99 kilowatt-hours a month. Why should anyone pay $50 more for a unit that is so similar? Over ten years the cheaper, less efficient model costs a total of $1170 (counting the selling price) while the more efficient model costs $955 - saving over $200.

Of course, not everyone has the cash to purchase a more efficient but also more expensive model, even though it would pay off in the long run. Or would it pay off even in the short run? Suppose you buy your appliance on a credit card which charges 18 annual interest. Suppose you pay off the selling price in three years. The expensive model is now even more expensive, because it has not only higher monthly charges to purchase the unit but also higher monthly interest charges. But at the same time it's costing you less on the monthly electric bill. A little calculation will show that the total monthly cost - counting your credit card payments and your electric bill is often less with the more efficient model.

Here's an example, the same one for the two 17 cubic-foot refrigerator-freezers we discussed above. In the first month, the payments are:

	$480 model	$430 model
Principal	$13.33	$11.95
Interest	7.20	6.45
Electric Bill	3.96	6.16
Total	$24.49	$24.56

In the first month, the expensive unit is actually 7¢ cheaper. Each month the difference becomes greater until after the three years are up the savings are $2.20 a month ($26.40 a year), every month. (Even more if electric rates have continued to increase.)

Let's return to the air conditioner examples to see the savings possible in power capacity. The inefficient unit draws an aditional 1380 watts. It is likely to be running on the hot summer afternoon when the electric utility has its peak demand. By law, the utility must provide you with that 1380 watts, and even have an extra 15% reserve. That makes nearly 1600 extra watts. New power plants cost about $500 to $1000 per kilowatt, according to the Iowa State Commerce Commission. Those extra 1600 watts mean an extra $800 to $1600 investment by the utility. It becomes obvious, then, that since that extra 1600 watts won't be needed most of the rest of the year, electric rates will have to rise for everyone so the utility can pay its costs.

Even the efficient air conditioner will cost the utility $800 or more in capital investment. It's just that the inefficient one will cost an extra $800 or more. The inefficient unit, which cost the consumer only $280, will require $1600 to $3200 capital investment by the utility! Actually the air conditioner might not be running on the peak demand day (the owner might be on vacation, for example), so this figure is hypothetical. However, even allowing for the possibility of some new appliances not contributing to peak demand, it is clear that a $1000 or $2000 investment might be required by the utility for an average room air conditioner (12,000 Btu/hour size).

$$\begin{array}{r} X \\ \text{Watts per hr. Input}\ \overline{\big)\,\text{BTU's per hr. Output}} \end{array} = \text{EER (Energy Efficiency Ratio)}$$

APPENDIX C

A COMPARISON OF ENERGY USE IN COOKING APPLIANCES

(info from the Pacific Gas & Elec. Co.)

1. Preheating the oven is a waste, as it requires from 9 to 28 per cent more energy.

2. Complete oven meals (4 to 6 foods) take relatively smaller amounts of energy than baking one or two foods separately. If six items are baked at one time, only one-third more energy is used in the gas oven and two-thirds more in the electric oven than if baking just one item.

3. The small eye-level oven saves 25 to 50 per cent more energy in comparison to the large lower oven, depending on temperature and length of cooking.

4. Microwave ovens are most efficient for defrosting, reheating, cooking in small quanities or when cooking individual items. For these uses they take less energy than conventional ovens. Because cooking a complete meal in a microwave means cooking each item individually, energy consumption, in this case, may run more than if all items were cooked at one time in the conventional oven. This depends on the number of items cooked. Anything less than four items, energy is saved in the microwave oven.

5. Continuous-cleaning ovens use from 1 to 22 per cent more energy than self-cleaning ovens, depending on temperature and length of cooking time.

6. Low temperature roasting (185°) uses 32 to 56 per cent more energy than roasting at a higher temperature (325°)

7. A forced air gas oven uses less total energy than a conventional oven and baking time is substantially reduced.

8. A complete broiler meal requires 10 per cent more energy than a complete oven meal. However, a complete meal cooked on the surface requires only about half the amount of energy needed for a broiler meal.

9. The smooth top surface units use about the same amount of energy as a standard unit. However, some models are more efficient than others.

10. A thermostatically controlled surface unit or burner uses two to 22 per cent less energy than a standard surface unit or burner.

11. Pressure cookers reduce length of cooking time and save 26 per cent to 42 per cent more energy than cooking in a saucepan on the top of the range. This applies to foods requiring steaming (puddings), simmering (corned beef), braising (less tender cuts of meat) and stewing (chicken).

12. Crockery or slow cookers use more energy than other types of surface cooking. A higher temperature for a shorter cooking period uses 12 to 22 per cent less energy than a lower setting for a longer cooking period.

13. Portable ovens, frypans, and broilers (in most instances) can save from 9 to 44 per cent energy when baking or broiling in small quantities.

14. Outdoor electric and gas grills use from 100 to 300 per cent more energy than other methods of cooking.

15. The gas pilotless ignition system saves approximately 40 per cent energy consumption.

OIL! FUEL OF THE PAST

(Petroleum - reserves, location, transportation,
and consumption)

Grade Level: Junior or Senior High
Time Required: Four to seven days
Recommended Subjects: Science, Social Studies

by

Gerald E. Potter
Charles Niemeyer
M. Andy Kirsch

Prepared for
the Nebraska Energy Office

ABSTRACT

Students do not understand the relationship between petroleum reserves, availability, location and associated problems such as transport, politics, and rates of consumption. The problem will be approached by use of projected world oil consumption and distribution in a simulation format with related activities and investigations.

RECOMMENDED LEVEL

May be used in the junior or senior high depending on the degree the teacher wants to develop the simulation.

TIME REQUIRED

4-7 days

MAJOR TEACHING STRATEGIES

The simulation game will involve the use of class discussion, observation, comparison, attitude clarification, inquiry, brainstorming and some lecture.

ADVANCE PREPARATION

Materials needed = Large world map for display in the front of the room or overhead transparency of world map

1 11x17 world map per student or group of students

1 cardboard backing per student map

140 steel pins per student map

Recommended advance reading for the instructor for use as background material and reference is the booklet National Executive Energy Summary Outlook (enclosed)

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GOALS

1. Student awareness of the rate of depletion of petroleum.
2. Student awareness of the locations of world petroleum reserves.
3. Student awareness of the transportation problems associated with the distribution of petroleum resources.
4. Student awareness of the political ramifications associated with transportation and use of petroleum resources.
5. Student awareness of the need for conservation of petroleum resources.

OBJECTIVES

1. The student will be able to identify on a map the approximate location of 95 percent of the known world oil reserves.
2. The student will be able to determine the effect of future rates of petroleum consumption on known world reserves.
3. The student will be able to list five reasons for today's emphasis on conserving world petroleum resources.
4. The student will be able to list five reasons for today's emphasis on finding alternative forms of energy.
5. The student will be able to list three possible political effects of the declining world petroleum reserves.
6. The student will complete a postest with the teachers predetermined rate of accuracy.

CLASSROOM ACTIVITIES

<table>
<tr><th>STUDENT ACTIVITIES</th><th>TEACHER ACTIVITIES</th><th>READY INFORMATION AND SUGGESTIONS</th></tr>
<tr><td>(a) Listen</td><td>(a) Introduction "Energy" (Supplement A)</td><td>(a) Teacher may demonstrate that once a fossil fuel is burned, it is lost forever.</td></tr>
<tr><td>(b) Pre-test (Supplement B)</td><td>(b) *Optional. While students take Pre-test, teacher may ready maps (Supplement C) and materials.
Mount maps (2 pieces) on a 17 x 11 piece of cardboard.
* The teacher may elect to dispense with the individual student maps and use a master world map with large pins, various colors, to show the oil reserves and depletion.</td><td>(b) Each student team needs one world map and 136 pins.
No introduction is given to the game at this time. While passing out maps, it should be mentioned they are to be used for studying oil reserves.</td></tr>
<tr><td>(c) Place pins on map at teachers direction to show oil reserves</td><td>(c) Pass out maps to students and give directions to students to place pins showing locations and amounts of oil reserves as shown below:
<table>
<tr><th>Country</th><th>(BB)
Oil</th><th>Pins</th></tr>
<tr><td>OPEC</td><td>450</td><td>90</td></tr>
<tr><td>N. America</td><td>40</td><td>8</td></tr>
<tr><td>W. Europe</td><td>25</td><td>5</td></tr>
<tr><td>Other Non-Communist</td><td>40</td><td>8</td></tr>
<tr><td>Communist</td><td>103</td><td>25</td></tr>
</table>
Each pin = 5 BB (Billion Barrels)
1 Barrell = 42 gallons</td><td>(c) Maps should be mounted on a 17 x 11 piece of cardboard or other material so pins can be placed easily.
Give freedom in placing pins. A discussion of boundaries etc. can come later approximate placement of pins will not detract from the objectives of the game but discussions can lead to valuable geographic concepts.
The Lesson should end with a lot of unanswered questions.
A large wall map should be ready for lesson two so students can check placement of pins. OHP could be used (Supplement C) giver a fairly accurate picture of reserves.</td></tr>
</table>

DAY TWO

STUDENTS ACTIVITIES	TEACHER ACTIVITIES	READY INFORMATION AND SUGGESTIONS
(a) Discussion	(a) Teacher led discussion of the geography of oil reserves.	(a) Emphasize these are proven reserves ultimately recoverable oil reserves are estimated to be as high as 2000 BB. At a higher cost of recovery.
	(b) Brief introduction to the game. (Supplement D)	
(c) Move pins as Teacher Directs to show imports.	(c) Give directions to students to move pins to indicate imports of oil. (1975-1980) Pins (1) Mid-East to W. Europe 3 (2) Mid-East to U.S. 2 (3) Mid-East to Asia 3 (4) S. America to U.S. 1 (5) S. America to W. Europe 1	(c) Point out that this is a five year import total. It is not important that you emphasize the barrel amoun it is the ratios that will be remembered.
(d) Remove pins to show consumption	(d) Give directions to students to remove pins to indicate consumption (1975-1980) (1) U.S. 6 pins removed (2) W. Europe 5 pins removed (3) Asia 3 pins removed	(d)

DAY TWO (Continued)

STUDENTS ACTIVITIES	TEACHER ACTIVITIES	READING INFORMATION AND SUGGESTIONS
(e) Discussion	(e) Discussion (Supplement E)	(e) Key Questions (1) Why aren't other countries included in the game? (2) Where are the oil reserves in the U.S.? (3) What part of the world's oil is in the Mideast? (4) What is OPEC? (5) What is an EMBARGO? (6) What factors determine if a country can buy oil? Question 3 Relates to Ratios and Percents and can lead to later discussions of what % of worlds oil is in MidEast and what % is used in U.S. A related question could be raised regarding populations of Saudi Arabia and U.S.

DAY THREE

STUDENT ACTIVITIES	TEACHER ACTIVITIES	READY INFORMATION AND SUGGESTIONS
(a) Discussion	(a) Continue Discussion from Day Two	(a) Of course other countries Consume Oil but these regions in the game consume most of it. Communist Countries produce and consume oil, but little is known about it.
(b) Move pins at teacher direction to show imports (1980-85)	(b) Give directions to students to move pins to indicate imports of oil. (1980-1985). (1) Mid-East to W. Europe 3 pins (2) Mid-East to U.S. 3 pins (3) Mid-East to Asia 3 pins (4) So. America to U.S. 2 pins (5) So. America to W. Europe 2 pins	(b) Key Questions (1) Have imports changed? (2) How would an oil embargo affect these imports? (3) What size are oil tankers? (4) How is this oil moved?
(c) Remove pins at teachers directions to show consumption.	(c) Give students directions to remove pins to show consumption: U.S. 7 pins W. Europe 6 pins Asia 3 pins	(c) Key Questions (1) What is happening to oil reserves (2) What parts of the world are totally dependent on imported oil?

DAY THREE (Continued)

STUDENTS ACTIVITIES	TEACHER ACTIVITIES	READY INFORMATION AND SUGGESTIONS
(d) Move pins according to handout	(d) Distribute Handout with data to show Imports (1985-1990) Consumption (1985-1990) Imports 1990-1995 Consumption 1990-1995 Imports 1995-2000 Consumption 1995-2000 (Supplement F)	(d) The reason for speeding up the game is to maintain interest. An alternate to the handout might be to assign the completion of the game by estimating imports and consumption for the periods 1985-90, 1990-95, 1995-2000.

DAY FOUR

STUDENT ACTIVITIES	TEACHER ACTIVITIES	READING INFORMATION AND SUGGESTIONS
(a) Complete game and compare results with others.	(a) Give directions to finish the game and draw conclusions.	(a) Students could work in small groups for comparisons or all maps could be compared with the teachers map.
(b) Discussion	(b) Teacher-led discussion summary and conclusions	(b) The summary can be large group, written paragraph, teacher led discussion or other method.
(c) Post Test	(c) Administer Post-Test (Supplement B)	(c) This test can be compared with the pre-test by the student or by the teacher. The computer program and sample printout might be used if a computer is available.

LIST OF SUPPLEMENTS

A. 0 ENERGY" -- INTRODUCTION

B. PRE TEST (POST TEST)

C. STUDENT OUTLINE MAP

C.[1] RESERVES MAP

D. INTRODUCTION TO THE GAME

E. REFERENCE MATERIAL

F. HAND OUT DATA SHEET

G. COMPUTER MODEL

INTRODUCTION

America's prosperity and high standard of living were built upon readily available, inexpensive and seemingly inexhaustible energy resources. Our industrial strength, agricultural bounty, comfortable homes, and fast and easy transportation of people and goods consumes high levels of energy, primarily from fossil fuels. Our fossil fuels (Coal, Petroleum, and Natural gas) are results of photosynthetic plants that have been buried and which have stored chemical energy for millions of years.

Nature still forms fossil fuels but the formation rate is "one million times slower that man's consumption rate". Due to this slow formation rate, fossil fuels can be classified as nonrenewable resources.

Oil is one of the most important of the fossil energy sources because of its versatility. It is the fuel for many utility companies, the combustion engine, and when highly refined, becomes the "gas" that runs our cars, trucks, airplance and industrial machinery. In another form it becomes a major heating fuel for homes, offices and factories. Petroleum is also the raw material in petrochemicals which are used in the manufacture of items such as lipstick, nylon stockings, toys, garbage bags, phonograph records, and hair curlers. Needless, to say, our national consumption of oil is astronomical.

At our present rate of use we are already short of native oil and have to depend on imports to make up the difference. Aside from the economics and political hazards of depending on foreign sources, there is the growing factor of competition from other nations. Already the demand for oil by Japan and European countries is growing faster than our own, and many of the developing nations are just getting into their own industrial revolutions.

The intent of the simulation is to give an insight into the future aspects of things that may affect oil supply in the world.

ENERGY OPINIONS

Directions: Read each statement and decide whether you agree with the statement, disagree with the statement, or just don't know. Check one response for each statement.

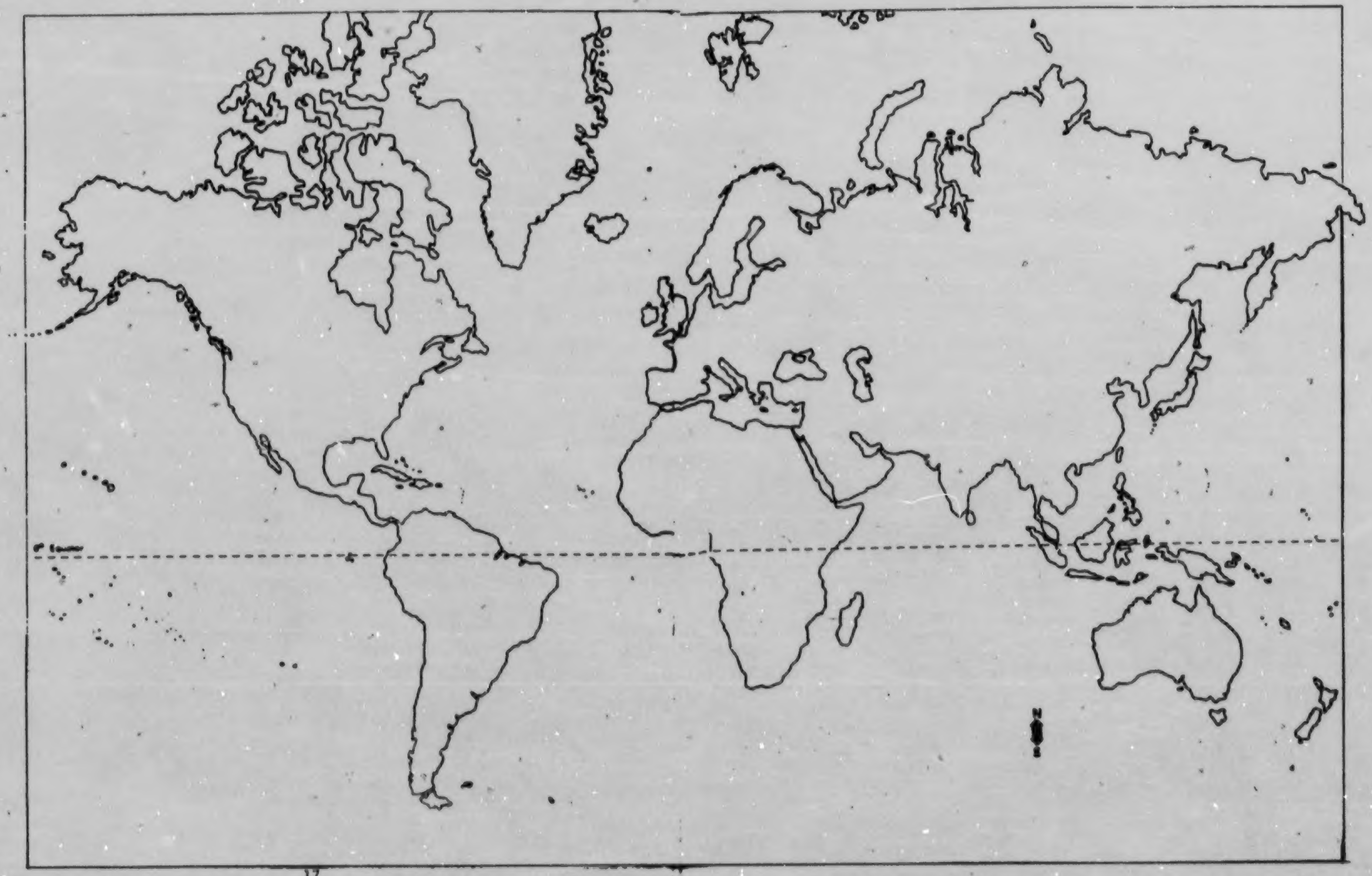
	Agree	Don't Know	Disagree
1. Fossil fuels such as oil and coal will run out sometimes in the future.	____	____	____
2. Before current energy sources run out we will discover others.	____	____	____
3. We should use more wood to cut down on our use of coal and oil.	____	____	____
4. Most of the energy used in the U.S. is used for transportation.	____	____	____
5. Most people would reduce the amount of energy they use if the price was twice as high.	____	____	____
6. To save energy I would be willing to buy a black and white instead of a color television set.	____	____	____
7. Citizens of the U.S. will never voluntarily reduce the amount of energy they use.	____	____	____
8. The U.S. now has about six percent of the world's population and consumes about one-third of the world's resources.	____	____	____
9. If we run out of petroleum in the U.S., we can always import it from other countries.	____	____	____
10. Industry is the largest single energy consumer in the U.S.	____	____	____
11. Although gasoline prices are high now, they will get lower in the future.	____	____	____
12. Small cars are ugly and uncomfortable.	____	____	____
13. Car pooling can save alot of fossil fuel.	____	____	____
14. Most people think that the whole gasoline shortage problem was something the oil companies created to increase their profits.	____	____	____

	Agree	Don't Know	Disagree
15. Less than 20 percent of the fuel consumed in the U.S. is imported from other countries.	______	______	______
16. Car designers pay more attention to how a car looks than to how much energy it uses.	______	______	______
17. Research and new inventions will solve our enrgy problems before fossil fuels run out.	______	______	______
18. Even though American cars use more gas they are built better and last longer than foreign cars.	______	______	______
19. If worst comes to worst I can get along without using any energy.	______	______	______
20. There is an energy shortage in the U.S.	______	______	______
21. Reducing the amount of energy we use will not necessarily reduce our quality of life.	______	______	______
22. With propoer maintenance, turbines, generators, and other machines could run at 100 percent efficiency.	______	______	______
23. We should pass laws limiting the amount of fuel that families can use for heating and cooling their homes.	______	______	______
24. We should pass a law that allows a family to have no more than two cars.	______	______	______
25. The way I personally use energy doesn't make any difference in the total energy use picture.	______	______	______
26. The price of petroleum affects the cost of most other things we buy.	______	______	______
27. The government should ration gasoline to citizens so our country can conserve energy.	______	______	______
28. Producing nuclear energy is a clean, safe way to produce unlimited supplies of energy.	______	______	______
29. When we run out of fossil fuels, we'll switch to electricity.	______	______	______
30. It is alright for foreign oil producing nations to charge as much for oil as they want to.	______	______	______

	Agree	Don't Know	Disagree
31. I would not really change the way I do things just to save energy.	______	______	______
32. I am willing to take cooler baths or showers to save energy.	______	______	______
33. Population growth rates have only a small influence on energy related problems.	______	______	______
34. Americans use more than their fair share of the worlds energy resources.	______	______	______
35. At current rates of research and development new technology will soon provide us with safe solutions to the energy problem.	______	______	______
36. Please write one sentence which you feel represents and summarizes your point of view concerning the much-discussed energy situation.	______	______	______

STUDENT MAP
SUPPLEMENT C

World Map



N. AMERICA: (8)
ALASKA 2
CANADA 2
CONTINENTAL U.S. (48 STATES) 4

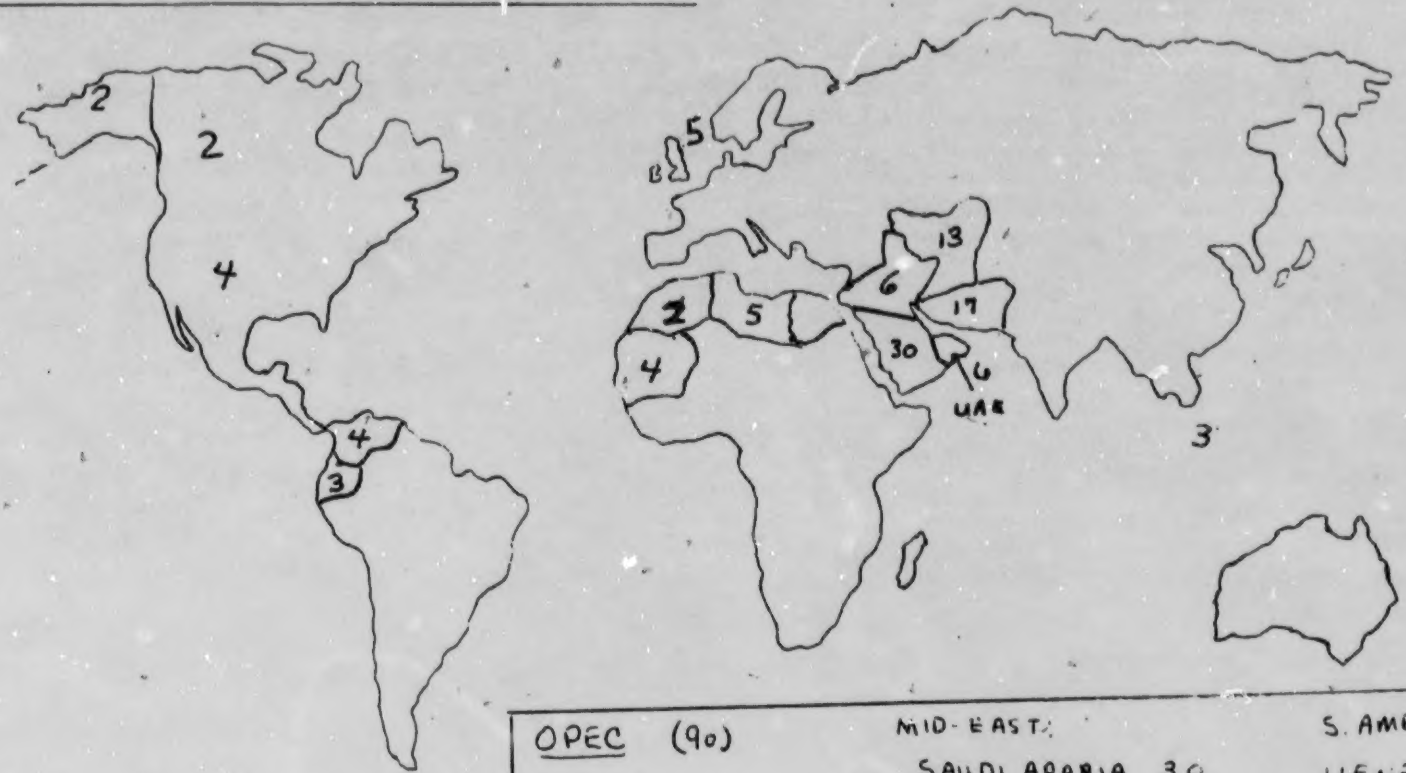
W. EUROPE: (5)
NORTH SEA ... 5

COMMUNIST: (25)

OTHER NON-COMMUNIST (8)
INDONESIA ... 3
OTHERS 5
(TRINIDAD, BOLIVIA, ANGOLA, EGYPT COLOMBIA ...)

IV - 17

Supplement C



OPEC (90)

AFRICA:

NIGERIA	4
LIBYA	5
ALGERIA	2

MID-EAST:

SAUDI ARABIA	30
KUWAIT	17
IRAN	13
IRAQ	6
UNITED ARAB EMIRATES	6

S. AMERICA:

VENEZUELA	4
ECUADOR	3

GAME INTRODUCTION (read to students)

SUPPLEMENT D

This game is structured to model reserves, imports, and consumption of oil in the world.

The first step is to place pins in your map to show approximate locations and amounts of oil reserves. You did this in your first lesson. Now is a good time to check with the wall map to make certain your map is correct. It is important that your map be the same as the wall map.

The second step is to move pins as your teacher directs to show imports of oil during a five year period. You must move the correct number of pins since the number is related to real world imports.

The third step is to remove pins to show consumption over the same five year period. The number of pins removed is important since the number is related to real world consumption.

After appropriate discussion etc., the game will continue as your teacher directs you to move pins to show imports for the next five year period. This is followed by directions for removing pins to show consumption for this five year period.

STUDENT HANDOUT **DATA

SUPPLEMENT F

The following figures are import and consumption figures for the time periods shown. Play the game one time-period at a time so that the trends become evident.

1985-1990

IMPORTS	PINS MOVED
(a) mid-east to W. Europe	4
(b) mid-east to U.S.	4
(c) mid-east to Asia	3
(d) S. America to U.S.	2
(e) S. America to W. Europe	0

CONSUMPTION	PINS REMOVED
(a) U.S.	7
(b) W. Europe	6
(c) Asia	3

1990-1995	PINS MOVED
(a) mid-east to W. Europe	5
(b) mid-east to U.S.	6
(c) mid-east to Asia	4
(d) S. America to U.S.	0
(e) S. America to W. Europe	0

CONSUMPTION	PINS REMOVED
(a) U.S.	7
(b) W. Europe	6
(c) Asia	4

continued on next page

STUDENT HANDOUT (continued)

1995-2000

IMPORTS	PINS MOVED
(a) mid-east to W. Europe	5
(b) mid-east to U.S.	6
(c) mid-east to Asia	4
(d) S. America to U.S.	0
(e) S. America to W. Europe	0

CONSUMPTION	PINS REMOVED
(a) U.S.	7
(b) W. Europe	6
(c) Asia	4

COMPUTER MODEL

SUPPLEMENT G

The sample printout and program are good ways of stimulating further research. The program is written in "WANG" BASIC and may have to be modified for other machines.

Several things about the printout are mind benders. For example, running out of Uranium by 1982 is hard to understand and may require some research to explain. The book "ENERGY" (the WAES report) shows "a large amount of additional production must be added to avoid uranium shortages in the early 1980's." A discussion of the tradeoffs involved in nuclear plants is a natural related topic.

Students may want to modify the program to allow for inputs of new and different growth rates and the finding of additional reserves such as the Mexico field. Another variation would be to investigate what would happen to the U.S. if an Arab boycott diminished our supply of crude oil. Gas rationing is another possible variation. The message is always the same "WE WILL RUN OUT OF PETROLEUM."

KEY QUESTIONS:

1. What can we do to make our oil supplies last past 2004?
2. What can be used to replace natural gas?
3. What nuclear technology would allow us to use this form of energy past 1982?
4. What energy sources can replace fossil fuels?

SAMPLE RUN

```
THIS IS A SIMPLIFIED MODEL OF ENERGY SUPPLY AND DEMAND IN THE COUNTRIES OUTSI
COMMUNIST AREAS.
THE MODEL BEGINS WITH  RESERVES FOR OIL, COAL,GAS, AND URANIUM IN 1975.

THE DATA WAS TAKEN FROM THE WAES REPORT USING INTERPOLATIONS,
EXTRAPOLATIONS AND INTERPRETATIONS AND TRY TO REFLECT THE INTENT OF THE REPORT

FUEL              RESERVES        ANNUAL USE      GROWTH RATE     NEW RESERVES
OIL-BARRELS        658000000000    20000000000     4.00000000E-02  15000000000
GAS-BBOE           242000000000    6020000000      2.00000000E-02  26000
COAL-MET TONS      4000000000000   1070000000      5.00000000E-02  15000000000
URANIUM-TONS       1800000         30000           .69             1000


REMAINING RESERVES
YEAR              OIL -BARRELS     COAL -MET TONS  GAS -BBOE        URAN -TONS
 1975              658000000000    4000000000000    242000000000     1800000
 1976              653000000000    4013930000000    235980026000     1771000
 1977              647200000000    4027806500000    229839652000     1721300
 1978              640568000000    4041626825000    223576470000     1636617
 1979              633070720000    4055388166250    217188023840     1492813.73
 1980              624673548800    4069087574563    210671808236.8  1249093.5137
 1981              615340490752    4082721753292    204025267801.6  836518.038153
 1982              605034110382.1  4096288050957    197245796087.7  138575.4844786
                                                                    OUT OF URANIUM
 1983              593715474797.4  4109782453505    190330734316.5 0
 1984              581344093789.3  4123201576181    183277370844.9 0
 1985              567877857540.9  4136541654990    176082939581.8 0
 1986              553272971842.6  4149798737740    168744619173.5 0
 1987              537483890716.3  4162968674627    161257531837   0
 1988              520463246345    4176047108357    153624742233.8 0
 1989              502161776176.8  4189029463777    145837256316.5 0
 1990              482528247746.8  4201710936966    137894020164.9 0
 1991              461509377136.7  4214686463815    129791918768.2 0
 1992              439649752222.2  4227350808006    121527774823.6 0
 1993              415091742311.1  4239898348406    113098347480.1 0
 1994              389575412003.6  4252323265826    104500331069.7 0
 1995              362438428463.8  4264617429117    95730353811.1  0
 1996              333615965623.2  4276780400573    86784976487.32 0
 1997              303040604548.2  4288799420602    77660691097.06 0
 1998              270642228418.2  4300669391632    68353919478.99 0
 1999              236347917555    4312382861214    58861011708.56 0
 2000              200081834257.2  4323932004275    49178245666.72 0
 2001              161765107627.5  4335308604467    39301823580.05 0
 2002              121315711932.6  4346504034715    29227872531.64 0
 2003              78648340407.9   4357509236449    18952441942.26 0
 2004              33674274026.28  4368314698271    8471502221.09  0
                  OUT OF OIL
                                                   OUT OF GAS
 2005              0               4378910433184   0                0
 2006              0               4389285954843   0                0
 2007              0               4399430252585   0                0
 2008              0               4409331765214   0                0
 2009              0               4418978353475   0                0
 2010              0               4428357271147   0                0
 2011              0               4437455134706   0                0
```

```
2014          0          4462916325313   0          0
2015          0          4470744241578   0          0
2016          0          4478211453657   0          0
2017          0          4485302026339   0          0
2018          0          4491997127656   0          0
2019          0          4498276984038   0          0
2020          0          4504120833235   0          0
2021          0          4509506874900   0          0
2022          0          4514412218645   0          0
2023          0          4518812629577   0          0
2024          0          4522683471055   0          0
2025          0          4525997644607   0          0
2026          0          4528727526837   0          0
2027          0          4530843903178   0          0
2028          0          4532316078336   0          0
2029          0          4533111903252   0          0
2030          0          4533197498414   0          0
2031          0          4532537373334   0          0
2032          0          4531094242000   0          0
2033          0          4528628754099   0          0
2034          0          4525700401803   0          0
2035          0          4521665421892   0          0
2036          0          4516678692986   0          0
2037          0          4510692627634   0          0
2038          0          4503657259015   0          0
2039          0          4495520121965   0          0
2040          0          4486226128062   0          0
2041          0          4475717434464   0          0
2042          0          4463933306186   0          0
2043          0          4450809971494   0          0
2044          0          4436280470068   0          0
2045          0          4420274493570   0          0
2046          0          4402718216247   0          0
2047          0          4383534129158   0          0
2048          0          4362640835615   0          0
2049          0          4339952877395   0          0
2050          0          4315380521264   0          0
2051          0          4288629547326   0          0
2052          0          4260201024691   0          0
2053          0          4229391075924   0          0
2054          0          4196290629719   0          0
2055          0          4160785161204   0          0
2056          0          4122754419263   0          0
2057          0          4082072140225   0          0
2058          0          4038605747235   0          0
2059          0          3992216034595   0          0
2060          0          3942756836323   0          0
2061          0          3890074678138   0          0
2062          0          3834008412043   0          0
2063          0          3774388632644   0          0
2064          0          3711038274275   0          0
2065          0          3643770187987   0          0
2066          0          3572388697385   0          0
2067          0          3496688132253   0          0
2068          0          3416452538864   0          0
2069          0          3331455165806   0          0
2070          0          3241457924095   0          0
2071          0          3146210820298   0          0
2072          0          3045451361311   0          0
2073          0          2938903929375   0          0
2074          0          2826279125842   0          0
2075          0          2707273082132   0          0
2076          0          2581566736237   0          0
2077          0          2448825073047   0          0
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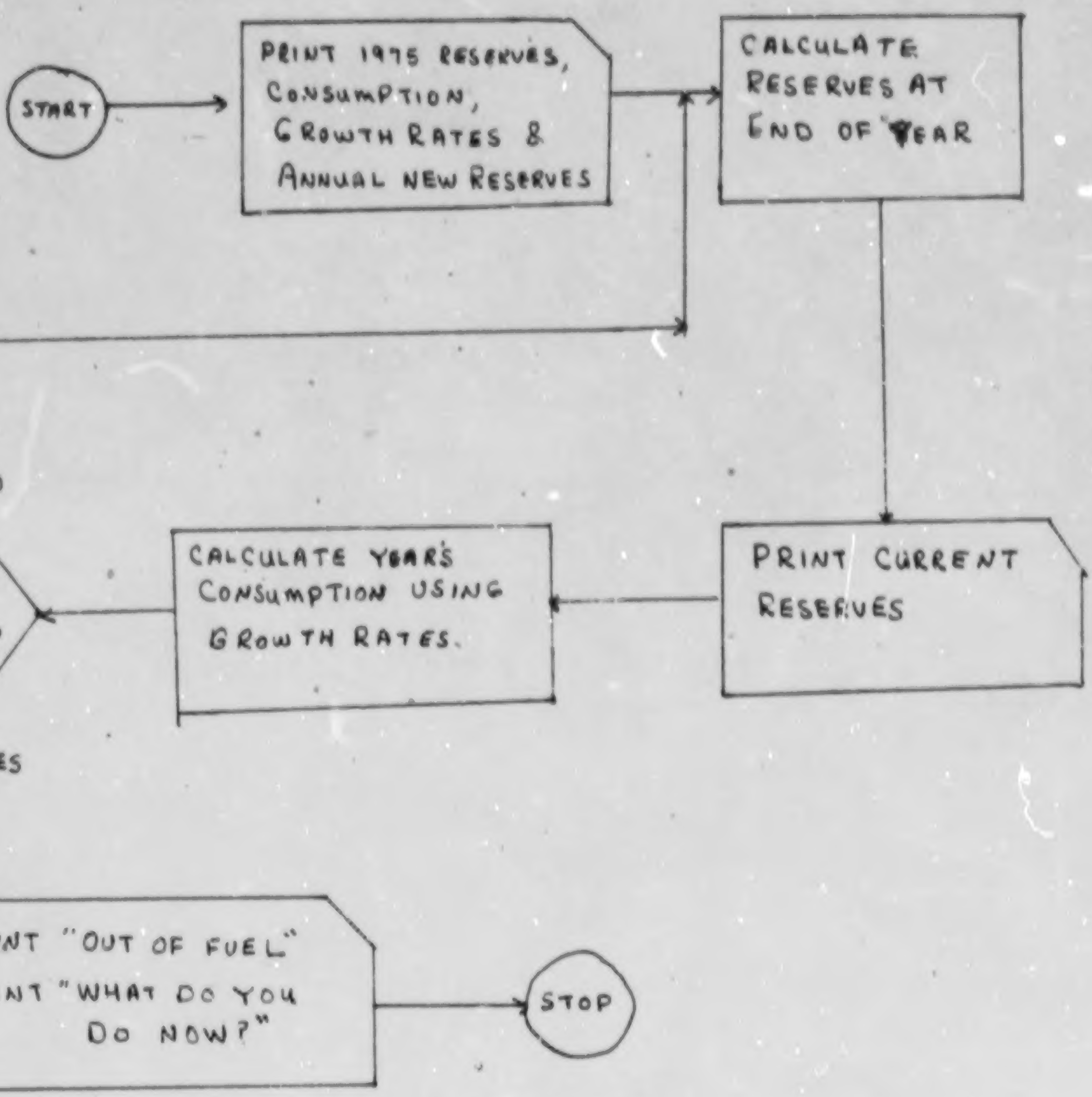
```
 2079          0                 2160811143030  0                 0
 2080          0                 2004781700180  0                 0
 2081          0                 1840200785187  0                 0
 2082          0                 1666640824444  0                 0
 2083          0                 1483652865664  0                 0
 2084          0                 1290765508945  0                 0
 2085          0                 1087483784390  0                 0
 2086          0                 873287973607   0                 0
 2087          0                 647632372284.7 0                 0
 2088          0                 409943990896.3 0                 0
 2089          0                 159621190438.5 0                 0
                                OUT OF COAL
 2090          0                0               0                 0
YOU ARE OUT OF ALL FUELS.
WHAT DO YOU DO NOW?
```

FLOW CHART - COMPUTER MODEL


START
PRINT 1975 RESERVES, CONSUMPTION, GROWTH RATES & ANNUAL NEW RESERVES
CALCULATE RESERVES AT END OF YEAR
PRINT CURRENT RESERVES
CALCULATE YEAR'S CONSUMPTION USING GROWTH RATES.
OUT OF FUEL?
NO
YES
PRINT "OUT OF FUEL" PRINT "WHAT DO YOU DO NOW?"
STOP

PROGRAM LISTING ON NEXT PAGE

```
10PRINT HEX(03):T=1975
20REM **INTRO**:SELECT PRINT 215(80)
30 PRINT "THIS IS A SIMPLIFIED MODEL OF ENERGY SUPPLY AND DEMAND IN THE COUNTRIE
S OUTSIDE COMMUNIST AREAS."
40 PRINT "THE MODEL BEGINS WITH  RESERVES FOR OIL, COAL,GAS, AND URANIUM IN 1975
."
50 PRINT
60PRINT "THE DATA WAS TAKEN FROM THE WAES REPORT USING INTERPOLATIONS,"
70PRINT "EXTRAPOLATIONS AND INTERPRETATIONS AND TRY TO REFLECT THE INTENT OF THE
 REPORT"
80X=0:Y=0:Z=0:Z1=0
90 DIM A$20
100 REM *GAS*
110 G=242E+9:G1=6.02E+9:R3=.02:G2=26E+3
120 REM *COAL*
130 C=4E+12:C1=1.07E+9:R2=.05:C2=15E+9
140 REM *OIL*
150 O=6.58E+11:O1=20E+9:R1=.04:O2=15E+9
160 REM *URANIUM*
170 N=1.8E+6:N1=.3E+5:R4=.69:N2=1E+3
180 A$="REMAINING RESERVES":B$="OIL -BARRELS"
190 C$="COAL -MET TONS":D$="GAS -BBOE":E$="URAN -TONS"
200PRINT
210PRINT "FUEL","RESERVES","ANNUAL USE","GROWTH RATE","NEW RESERVES"
220PRINT "OIL-BARRELS",O,O1,R1,O2
230PRINT "GAS-BBOE",G,G1,R3,G2
240PRINT "COAL-MET TONS",C,C1,R2,C2
250PRINT "URANIUM-TONS",N,N1,R4,N2
260PRINT
270 PRINT :PRINT :SELECT PRINT 215(80)
280 PRINT A$
290 PRINT "YEAR",B$,C$,D$,E$
300 PRINT T,O,C,G,N
310IF X=0THEN 320:IF Y=0THEN 320:IF Z=0THEN 320:IF Z1=0THEN 320:GOTO 600
320O=O-O1+O2:G=G-G1+G2:C=C-C1+C2:N=N-N1+N2
330IF O<=0THEN 520
340 IF C<=0THEN 540
350 IF G<=0THEN 560
360 IF N<=0THEN 580
370T=T+1
380PRINT T,
390IF O<0THEN 400:PRINT O,:GOTO 410
400PRINT "0",
410IF C<0THEN 420:PRINT C,:GOTO 430
420PRINT "0",
430IF G<0THEN 440:PRINT G,:GOTO 450
440PRINT "0",
450IF N<0THEN 460:PRINT N:GOTO 470
460PRINT "0"
470O1=(1+R1)*O1
480 G1=(1+R3)*G1
490 C1=(1+R2)*C1
500 N1=(1+R4)*N1
510 GOTO 310
520IF X=0THEN 530:GOTO 340
530 PRINT ,"OUT OF OIL":X=1:GOTO 340
540IF Y=0THEN 550:GOTO 350
550 PRINT ,,"OUT OF COAL":Y=1:GOTO 350
560IF Z=0THEN 570:GOTO 360
570 PRINT ,,,"OUT OF GAS":Z=1:GOTO 360
580IF Z1=0THEN 590:GOTO 370
590 PRINT ,,,,"OUT OF URANIUM":Z1=1:GOTO 370
600PRINT "YOU ARE OUT OF ALL FUELS.  "
610 PRINT HEX(0E),"WHAT DO YOU DO NOW?"
```

RESOURCES:

BROCHURES AND BOOKLETS

The following are available from the Nebraska State Energy Office, 301 South Centennial Mall, P. O. Box 95085, Lincoln, NE 68509

1. *OIL*; Energy Research and Development Administration
2. *OIL*; William W. Eaton
3. *Energy In Focus*; U.S. Department of Energy

OTHER

1. Living With Energy: Director, Youty and Educational Activities, Standard Oil Company. (Indiana), Mail Code 3705, 200 East Randolph Drive, Chicago, Ill 60601 (A free set of transparencies) Available from ESU #5.
2. *The Energy Crisis*; - What You Can Do About It; Same Sources as *Living With Energy*. (A set of transparencies)
3. ENERGY; Academic Press, 111 Fifth Avenue, N.y, N.Y., 10003, (Outstanding New Titles For Your Reference Library).

BOOKS

1. THE U.S. FACT BOOK; Bureau of The Census and Department of Commerce, Bookstore, $3.95
2. ENERGY; Carrol L. Wilson, Project Director of the WAES Report, Bookstore, $6.95
3. EXPLORING ENERGY CHOICES; S. David Freeman, Project Director, Ford Foundation Energy Policy Project, Bookstore, ESU #2.
4. PLANT AT A CROSSROADS, Robert Dwyer, Millikin Publishing Co., St. Louis, MO, $7.95. (A book with some overhead transparencies and duplicating masters), ESU #2.
5. ENERGY AND ECOLOGY; Youth Foundation, 10 E. 40th Street, N.Y., N.Y., 10016, $6.95. (A book of transparencies with diagrams of how things work, news clippings, games), ESU #2.
6. ENERGY CRISIS; Wendell Curry, Project Coordinator, State Department of Education, 942 Lancaster Drive NE., Salem, OR 97310 (A set of Activities)
7. ENERGY, ENVIRONMENT, AND EDUCATION; The Energy Conservation Foundation, 1717 Mass. Ave., N.W., Washington, D.C. 20036 (A book with issues and answers in 1973).

RESOURCES:

FILMS AND TV

Available free loan from DOE Film Library - TIC, P.O. Box 62, Oak Ridge, TN 37830.

1. TRANSPORTATION-THE WAY AHEAD; 7:45 min., color (a look at America's dependence on the automobile and at a future with gasoline in short supply)
2. THE ULTIMATE ENERGY; 28 min, color, (A look at the new technology of fusion)
3. THE SOLAR GENERATION; 21 min, color, (A look at the history of solar energy use and a glimpse of the future).
4. SUN POWER FOR FARMS; 12; 23 min., color (takes you around the country to solar projects)
5. LOOK TO THE SUN; 12; 20 min., color, (principles of solar use)

Available from ESU #2

1. ENERGY FOR THE FUTURE; 17 min., color (alternative energy sources)
2. CONSERVING OUR NATURAL RESOURCES; 17 min., color (renewable and nonrenewable resources)
3. CONSERVATION OF ENERGY; 27 min., color (Demonstrates conservation law).
4. ENERGY, THE DILEMNA; 20 min., color (growth problems, supply and demand, depletion of fossil fuels, economic and social problems)
5. ENERGY, LESS IS MORE; 18 min., color (need for slowing energy consumption)
6. ENERGY, NEW SOURCES; 20 min., color (potential and limits of new technology).
7. ENERGY, THE NUCLEAR ALTERNATIVE; 30 min., color (fission power, how it works, controversies)

FILMS

1. ENERGY; (a series of TV programs dealing with energy) Consult your ITV catalog
2. NOVA Series of TV programs; 210 CBA Center for Economic Education, UNL, Lincoln. Of this series we recommend; THE OTHER WAY; 40 min., color smaller is beter idea in the use of energy)

ENERGY: YESTERDAY, TODAY AND TOMORROW

AN INTERDISCIPLINARY APPROACH

(Energy Basics)

Junior High School
Science and Social Studies

Each three units are about one to two weeks in length.

by

Susan D. Pierce	Richard W. Lovrien
Nikki J. Scott	Patty Kondo
Dianne J. Kennedy	Geri J. Imel

Prepared for

the Nebraska Energy Office

I. ABSTRACT

Probably no issue today is more far-reaching or controversial or important to our way of life than the issue of how we use our energy resources. Decisions we make today will determine our options for tomorrow. In this packet of materials, students will have an opportunity to examine some elements of our energy situation today and make some determination about the kinds of decisions we should be making. The first unit is a general overview of the different kinds of energy resources and serves as an introduction to the problems involved with supplying our ever-increasing energy needs. The second unit uses social studies skills to explore this problem further. It begins with a brief history of our fuel sources and consumption and then requires students to look at personal attitudes as they relate to the way we use our energy. The third unit uses science skills to enable students to experiment with a variety of energy resources.

II. RECOMMENDED LEVEL

This packet of three units is designed for use with jr. high social studies and/or science classes.

III. TIME REQUIRED

Each of the three units in this packet are approximately 1-2 weeks in length (50 minute class periods). Again, it is recommended that the first unit be used with either or both of the last two units. Obviously, any unit can be extended by adding your own activities or by using some challenging activities or it can be shortened by deleting some activities or by assigning some activities for homework or for students to do on their own.

IV. MAJOR TEACHING STRATEGIES

In each unit of this packet we have attempted to include as large a variety of teaching strategies and activities as possible. This will be especially important to keep the student's attention and interest if the teacher decides to do all three units in the packet. Skill development (in both social studies and science areas) and attitude clarification are essential to our plan. Class discussion, comparison and inquiry are also used.

V. ESSENTIAL ADVANCE PREPARATION

Materials needed for the lessons in this packet are listed preceding each lesson. Most lessons can be done by using this packet alone. Some pages of this unit can be used to make ditto masters or transparencies for classroom activities.

VI. GOALS

When students complete this packet, they should be able to make the following generalizations about energy:

1. Many energy sources we now depend upon are non-renewable sources.
2. Conservation of these resources is important.
3. Alternative energy sources will be significant factors in our future lifestyle.
4. The energy crisis affects everyone.

VII. BEHAVIORAL OBJECTIVES

UNIT #1:

Upon completion of this unit students will be able to:

1. State why the study of energy is important today.
2. Identify their own attitudes concerning the energy problems of today.
3. Gain information about the different sources of energy by collecting information from charts and graphs.
4. Identify energy sources which could be alternatives to fossil fuels.
5. Demonstrate their ability to use a glossary to find definitions of words related to energy.
6. Find on their own more information about one alternative energy source.

UNIT #2:

Upon completion of this unit students will be able to:

1. Explain a timeline demonstrating the extremely brief age of fossil fuels in relation to their formation during geological time.
2. List 10 ways that plentiful energy has made their lives more comfortable than the life of the colonial American.
3. Examine their personal attitudes towards energy consumption and write a paragraph expressing their philosophy.
4. Compare the energy consumption of major household appliances and list 10 practices that will conserve energy in the home with a minimum of inconvenience.

UNIT #3:

Upon completion of this unit students will be able to:

1. Define fuel, energy, renewable and non-renewable.
2. List two renewable forms of fuel and 3 non-renewable forms of fuel.
3. Describe two problems associated with mining or using coal.
4. Collect methane gas from coal.
5. Determine the heat content of oil.
6. Operate a motor using a solar cell.
7. Design a model solar home.
8. Determine which direction (north or south) best utilizes solar energy.
9. Design and build a solar collector.
10. Define nuclear fission and nuclear fusion.

VIII. CLASSROOM ACTIVITIES/LESSON PLANS

The activities are listed on the following pages according to units.

UNIT #1

GENERAL AWARENESS-ENERGY TODAY

This curriculum unit consists of six sections.

A. Knowledge Pre-test

B. Discussion of the energy problems

C. Attitude Survey

D. Facts about energy

E. Alternatives to fossil fuels

F. Glossary of energy terms

NOTE: All worksheets for activities follow the directions.

DAY 1

The Knowledge Pre-test is included to stimulate student awareness of their own knowledge about energy. Copies of this test can be obtained from the Nebraska State Energy Office.

After the students complete the pre-test, the teacher should then discuss the energy problem. Some points to include in the discussion are:

1. a definition of energy,
2. a list of facts about energy with which students are already familiar.
3. a list of problems associated with energy,
4. why a study of energy is important today. (the teacher may wish to have students write out their feelings on this topic)

DAY 2

Make one copy per student of the energy inventory and one transparency per class of the inventory.

Have students complete the inventory, tally the results and discuss areas of greatest differences.

DAY 3 and 4: Facts about Energy

This section of the awareness curriculum consists of six activities. These activities are:

time required	Activity
1/2 period	1. How Nebraska uses energy.
1/2 period	2. What do we use for energy?
1/2 period	3. What's the problem?
1/2 period	4. Past, present, and future: The Energy Picture.
1/2 period	5. Coal
1/2 period	6. Natural Gas

The first four activities are suggested as the core of this section. The final two, Coal and Natural Gas, are included as supplemental activities. The teacher may substitute either of these activities for what's the problem?, or use them for homework, extra work for exceptional students, or as additional activities to reinforce the concept of limited fuel.

Below is a summary of each activity and suggestions for implementation.

How Nebraska Uses Energy

CONCEPTS:
1. Energy is used in all sectors of society.
2. Transportation and residential energy use accounts for over 50% of the total energy used in Nebraska.
3. There are many ways the student can conserve energy at home.

IMPLEMENTATION:

1. Each student is given this activity in handout form.

2. The graph is explained as being a breakdown by precentages of how energy is used in Nebraska. If this is the students first exposure to a bar graph, the teacher may want to spend some time explaining how to read the graph.
3. Students complete the activity on their own.
4. Class discussion on questions 3 and 4.

CLASS TIME: 1/2 period

What Do We Use For Energy?

CONCEPTS:
1. Fossil fuels account for 80-90% of the total fuel consumption in the United States.
2. The United States is dependent on fossil fuels.
3. Nebraska is dependent on fossil fuels.

IMPLEMENTATION:

1. Each student is given this activity in handout form.
2. The two graphs are explained as a breakdown by fuel types of energy consumption in the U.S. and in Nebraska. If the students are not familiar with pie graphs, the teacher may wish to explain how to read the graphs.
3. The students complete this acitivity on their own. (The teacher may choose to do this as a whole class activity and answer the questions together)

A Note About Question 7: At this point, students may not know what coal, natural gas, petroleum, nuclear and hydroelectric energy are, and it may seem difficult for them to determine which are fossil fuels and which are not. However, learning may take place by having the students state which ones are fossil fuels based upon prior knowledge.

CLASS TIME: 1/2 period

What's the Problem?

CONCEPTS:

1. The U.S. must import much of its oil.
2. Most of the worlds oil reserves are found in OPEC nations. (Organization of Petroleum exporting countries).
3. Someday reserves will be exhausted.
4. Nebraska does produce some oil but not enough to meet oil demands in Nebraska.

IMPLEMENTATION:

1. Each student is given this activity in ditto form.
2. The table is explained to them. The teacher should explain what is meant by "OPEC". (see the glossary)
3. Students are given time to complete the activity.
4. Students may require much help in doing the math work on questions 4,5, and 6.
5. Question 7 may be extra credit or required at the teachers discretion.

CLASS TIME: 1/2 period.

Past, Present, and Future: The Energy Picture

CONCEPTS:

1. Since 1850, several trends have occurred in energy consumption by fuel type.
2. By 2020, it has been predicted that petroleum, nuclear, solar, and coal energy will be used almost equally in the U.S..

IMPLEMENTATION:

1. Each student should be given the activity in ditto form.
2. The graph is presented as a line graph explaining the trends during the past 130 years in energy consumption by fuel type. If the students have not used a line graph previously, the teacher may wish to spend some time explaining how to read the graph.
3. Students complete the activity.

4. The teacher may wish to use question 6 as a discussion question.

CLASS TIME: 1/2 period

Coal and Natural Gas

CONCEPTS:
1. Both coal and natural gas have eventual limits in quantity and, although deposits are extensive, supplies are not infinite.
2. Nebraska has some coal deposits.
3. The mining of coal may be environmentally unacceptable.

IMPLEMENTATION:
1. Students are given the activities in ditto form.
2. Students complete the activities. Some students may require help in doing the math work for the Natural Gas activity. Some students may also require help in reading the maps and chart for the Coal activity.
3. A topic for discussion may be the environmental issues surrounding coal production.

CLASS TIME: Coal - 1/2 period
Natural Gas - 1/2 period

DAY 5 AND 6: ALTERNATIVES TO FOSSIL FUELS ACTIVITY

The purpose of this activity is to introduce and familiarize students with some alternatives to fossil fuels so they will begin to build a base of knowledge for further energy studies. The activity is designed so students will study in depth one alternative energy source and will be introduced briefly to each of the others.

Steps to Implement this Activity

Step 1. List the eight alternatives on a transparency. These alternatives are:

a. Solar energy
b. Gasohol
c. Hydroelectric
d. Geothermal
e. Nuclear (fission and fusion)
f. Biomass
g. Solid Waste
h. Wind

Step 2. Lead a discussion about why we need to look toward alternatives to fossil fuels. Some points to discuss are:

a. Fossil fuels are limited in quantity.
b. Fossil fuels are non-renewable.
c. Often, the processing of fossil fuels is costly.
d. Processing of fossil fuels can sometimes damage the environment.
e. The U.S. is dependent upon imported oil and the cost of the imported oil is hurting the U.S. economy.

These points are suggestions only, and the teacher may want to limit the discussion to one or two points or expand the list as he/she feels is appropriate.

Step 3. Divide the class into 8 groups.

Step 4. Give the groups the writing assignment.

Writing Assignment: Each group will write a definition for the energy source they are studying. Supplemental materials pertaining to the source must be available to the students. See attached list of suggested materials.

Each group will be prepared to give a short presentation to the class which will include:

a. a definition of the energy source
b. availability of the source
c. how the source might be used to generate power
d. a brief summary of a magazine or newspaper article about the source. Students should underline any words in the article that they are not familiar with and locate those words in the glossary. The teacher may require that the students be prepared to answer questions during their presentation concerning the unfamiliar words.

Each group will be given a transparency with a symbol for their source to be used in their presentations. Room has been left at the bottom of these transparencies for students to write in important information from their presentations.

The teacher may also wish to have the transparencies made into ditto masters and have copies made of each symbol for each student to jot down significant information from the group presentations.

Step 5. Group presentations

Step 6. Evaluation.

Since each teacher prefers a certain form of evaluation with which he/she feels comfortable, evaluation is left to the teachers discretion.

Glossary of Energy Terms:

This glossary is included to help students understand words with which they are not familiar.

KNOWLEDGE PRETEST:
(answers on back)

Just for fun and discussion, use a
lead-in to "Why study about energy?"
(copy also in Citizens Workshop Handb

Test Your E.Q.*

Take this quiz to check your knowledge and understanding of energy-environment issues. Check your answers below.

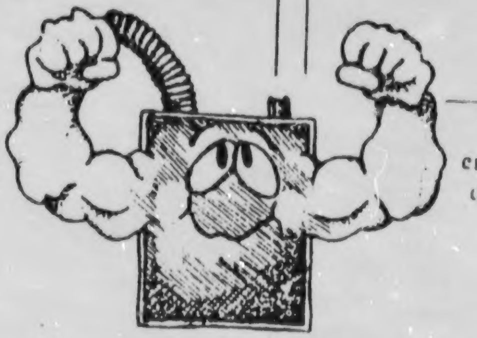
1. ____ How much of the energy used in gas stoves supplies the pilot lights?
   a. 10%
   b. 25%
   c. 50%

____ 2. An incandescent lamp and a fluorescent lamp having the same light output: Which uses energy more efficiently?
a. fluorescent
b. incandescent
c. both about the same efficiency

____ 3. How many soft drink cans can be manufactured from recycled aluminum with the energy needed to make a single can from aluminum ore?
a. three
b. five
c. twenty

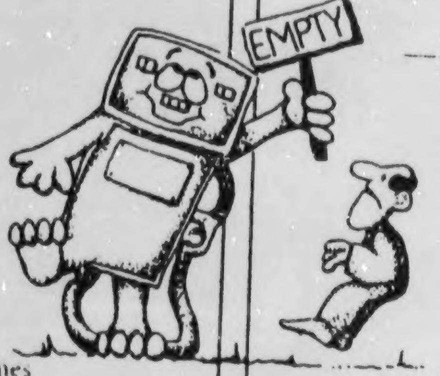
____ 4. How long would a 100-watt light bulb burn on the energy needed to manufacture one throw-away soft-drink can or bottle?
a. 10 minutes
b. 5 hours
c. 20 hours

____ 5. How much of the energy stored in crude petroleum is lost between the oil well and a moving car?
a. 20%
b. 60%
c. 90%



____ 6. The heat energy of a gallon of gasoline is equivalent to:
a. 5 man-days of labor
b. 15 man-days of labor
c. 25 man-days of labor

____ 7. How much faster than their rate of production are we consuming our fossil fuels?
a. 10 times
b. 1,000 times
c. 1,000,000 times



____ 8. What fraction of the world's energy consumption occurs in the U. S.?
a. over 10%
b. over 20%
c. over 30%

____ 9. Which of the following fuel resources is in greatest danger of exhaustion?
a. coal
b. petroleum
c. natural gas

____ 10. In the year 2000, American total energy demand will be:
a. the same as today
b. twice as much as today
c. three times as much as today

* Energy Quotient

V - 14 - a

E.Q. ANSWERS

Score 1 for each correct answer.
0—5 Poor, 6—7 Fair, 8—10 Good.

1. (c) Approximately half of the gas used in a gas stove is used to fuel the pilot lights because pilot lights burn continuously

2. (a) Fluorescent lights give off three to four times as much light per watt of electricity used as incandescent lamps do One 40-watt fluorescent light gives more light than *three* 60-watt incandescent bulbs (and the annual savings may be as much as $10)

3. (c) Aluminum is a very energy intensive material with the largest share of the energy going to process the ore Recycling is a great energy saver The Nation's total throwaway containers equivalent energy waste is equal to the output of 10 large nuclear power plants

4. (b) A 100-watt lamp could burn for 5 hours on the energy used to manufacture a disposable can or bottle

5. (c) Ninety per cent of the energy in the gasoline from crude petroleum is lost in making your car move The efficiencies of the most important steps where energy is lost are

producing the crude oil	96%
refining	87%
gasoline transport	97%
engine thermal efficiency	29%
engine mechanical efficiency	71%
rolling efficiency	30%

The total efficiency of the system is found by multiplying the six factors together 6%

6. (b) 15 man days of labor Said in another way one barrel of oil contains heat energy equivalent to the energy of a man at hard labor for 2 years

7. (c) In less than 500 years man will have consumed essentially all of the coal, oil and gas that nature started forming 500 million years ago By comparison, that same fraction of a calendar year is approximately 30 seconds

8. (c) More than a third of the world's energy is consumed by the 6% of the world's population residing in the United States

9. (c) Natural gas reserves in the United States are expected to be exhausted in about 40 years Petroleum should last for a century, coal, 500 years or so

10. (b) For more than a century America's demand for energy has doubled, on the average, every 20-25 years

V - 15 - a

ENERGY INVENTORY

This is not a test. This is not a test.

The following questions are designed to help you determine what you know about energy and to help you examine some of the attitudes you have toward energy use. You will not be graded on this inventory because for many of the questions there are no "right" answers; it is simply a matter of what you think or feel.

Directions: Read each statement and decide whether you agree with the statement, disagree with the statement, or just don't know. Check one response for each statement.

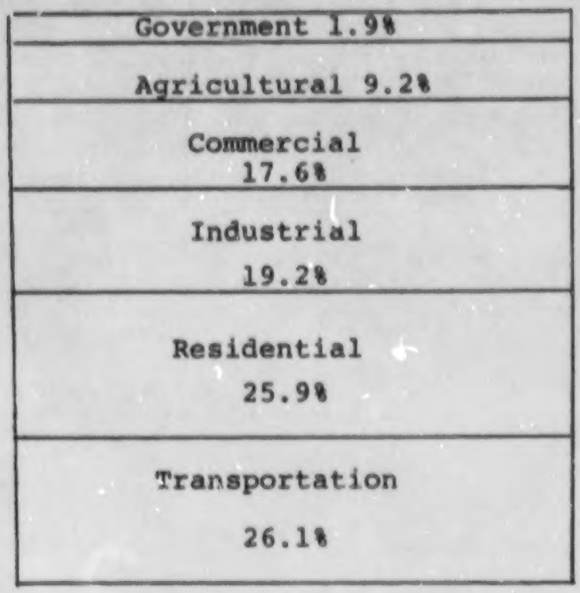
	Agree	Don't Know	Disagree
1. Industries should pay higher prices per unit of energy than anyone else.			
2. Before current energy sources run out, we will discover others.			
3. We should use more wood to cut down on our use of coal and oil.			
4. The government should give a tax break to people who drive small cars.			
5. Most people would reduce the amount of energy they use if the price were twice as high.			
6. Restricting the amount of trucking of goods between states would be a good way to save gasoline.			
7. To save energy, I would be willing to buy a black and white instead of a color television set.			
8. Industry and big business are the biggest producers of pollution.			
9. As long as other people are driving big cars there is no reason my family should not.			

	Agree	Don't Know	Disagree
10. The U.S. now has about six percent of the world's population and consumes about one-third of the world's resources.			
11. Air pollution standards should be dropped until a long-term, reliabel energy source is developed.			
12. Citizens of the U.S. will never voluntarily reduce the amount of energy they use.			
13. Business should spend more money protecting the health and safety of their employees than they do now.			
14. Although gasoline prices are high now, they will get lower in the future.			
15. Business and industry should pay most of the cost of cleaning up air and water pollution.			
16. I want a car of my own.			
17. I want a fireplace in my home because fireplaces are pleasant and romantic.			
18. Most people think that the whole gasoline shortage problem was something the oil companies created to increase their profit.			
19. Most of our air pollution problems are caused by our use of energy.			
20. Less than 20 percent of the fuel consumed in the U.S. is imported from other countries.			
21. The people of the U.S. should reduce their energy consumption so other nations can have enough energy to enjoy the conviences we have.			
22. If bus service were available, I'd be willing to use a bus rather than a car to run around town.			
23. People get more colds when their homes are heated to 68°F than when their homes are heated to 72°F.			
24. Research and new inventions will solve our energy problems before fossil fuels run out.			
25. People shouldn't worrry about turning out			

		Agree	Don't Know	Disagree
	lights in a motel or hotel room because the cost is included in their bill.			
26.	Even though American cars use more gas, they are built better and last longer than foreign cars.			
27.	Hanging clothes out to dry is more sensible than using a gas or electric dryer			
28.	If worst comes to worst, I can get along without any energy.			
29.	There is an energy shortage in the U.S.			
30.	Reducing the amount of energy we use will not necessarily reduce our quality of life.			
31.	Private citizens can have more influence on energy conservation than can government or big business.			
32.	Buying more material things than we need is a major cause of our energy shortage.			
33.	A diet that has a lot of meat in it is more efficient in terms of energy use than is a diet of mostly vegetables.			
34.	We should pass laws limiting the amount of fuel that families can use for heating and cooling their homes.			
35.	Hot showers use less energy than hot baths.			
36.	Public utilities should not be allowed to advertise to increase the demand of energy.			
37.	We should pass a law that allows a family to have no more than two cars.			
38.	The cost of maintaining natural systems such as national parks isn't worth the benefits.			
39.	The way I personally use energy doesn't make alot of difference in the total energy use picture.			
40.	The price of petroleum affects the cost of most other things we buy.			
41.	The government should ration gasoline to citizens so our country can conserve energy.			
42.	Producing nuclear energy is a clean, safe way to produce unlimited supplies of energy.			
43.	When we run out of fossil fuels, we'll switch to electricity.	100		

	Agree	Don't Know	Disagree
44. It is all right for foreign oil-producing nations to charge as much for oil as they want to.			
45. I would ride my bike or walk rather than ride in a car if it helped save energy.			
46. I would be willing to attend football games right after school rather than at night to save lighting energy.			
47. Conserving energy will cause people to lose jobs.			
48. Energy conservation is one of the most important objectives of my generation.			
49. My individual efforts can help solve the energy problem.			
50. I would not really change the way I do things just to help save energy.			
51. Individuals like myself should not be expected to help pay the cost of finding new ways to conserve.			
52. I am willing to take cooler and/or shorter showers or baths to help save energy.			
53. The federal government should make solving our energy problems one of its highest priorities.			

HOW NEBRASKA USES ENERGY



NEBRASKA STATE ENERGY OFFICE, 1977

1. This graph divides energy use in Nebraska into six groups. What group uses the most energy? ______________________

2. Rank the other groups in order from largest user to smallest user.

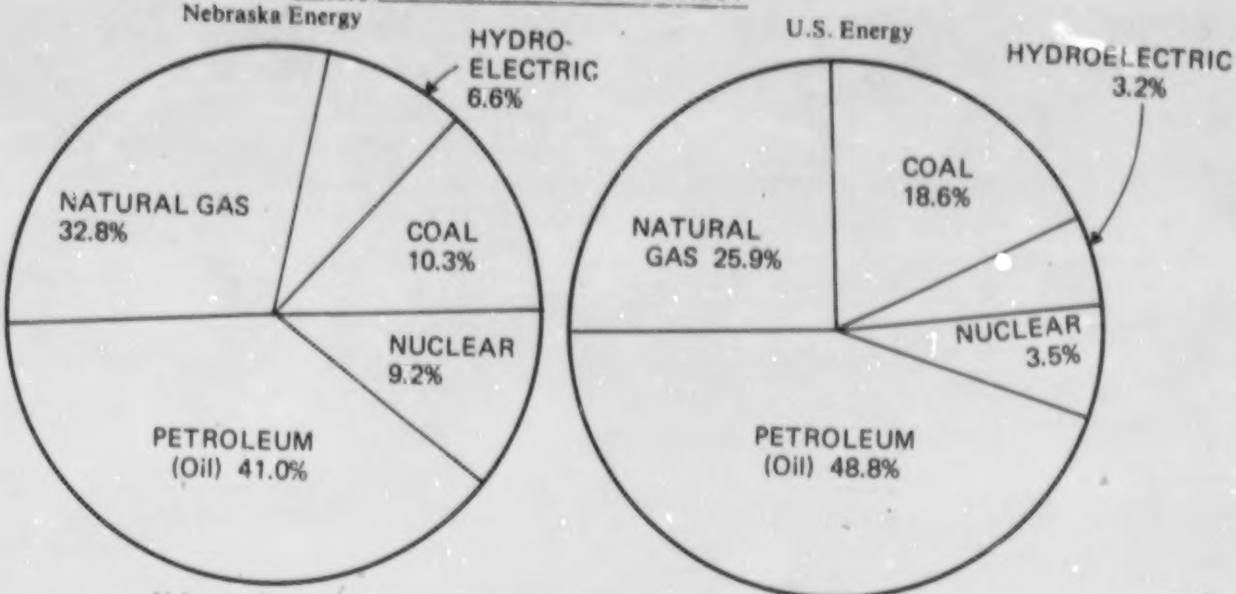
   1. Transportation ______ 26.1%
   2. ______________ ______
   3. ______________ ______
   4. ______________ ______
   5. ______________ ______
   6. ______________ ______
   7. ______________ ______
   8. ______________ ______
   9. ______________ ______

3. From the graph you can see that Nebraskans use a lot of energy in homes. List five ways you use energy at home.

   1. ______________________
   2. ______________________
   3. ______________________
   4. ______________________
   5. ______________________

4. What is one way you could save energy at home? ______________________________

WHAT DO WE USE FOR ENERGY?



Nebraska Energy Office

U.S. Department of Energy

Using the pie graphs above, answer the following questions.

1. What energy source is used the most in Nebraska? ______________________

2. What energy source is used the most in the U.S.? ______________________

3. Complete the columns below listing in order from largest to smallest the types of energy used in the U.S. and in Nebraska.

UNITED STATES			NEBRASKA	
1.	Petroleum	41%	Petroleum	48.8%
2.				
3.				
4.				
5.				

4. Compare the two graphs. Who uses a greater percentage of nuclear energy, the United States as a whole or Nebraska? ______________

5. Compare the two graphs. The United States as a whole uses coal for 18.6% of its energy. What percentage of Nebraska's energy is from coal? ______________

6. In both the United States and in Nebraska, natural gas and petroleum are used in much greater percentages than the other energy sources.

6. (cont).

What is the sum of the natural gas and petroleum use in the United States? ______________

What is the sum of the natural gas and petroleum use in Nebraska?

____

7. A fossil fuel is any fuel formed from the material of plants and animals over millions of years under particular conditions of temperature and pressure.

Of the five major sources of energy, we have studies with these two graphs, which sources are fossil fuels? ________________

____

____

8. Would you say the United States is dependent upon or independent of fossil fuels for energy?

dependent ______

independent ______

Would you say Nebraska is dependent upon or independent of fossil fuel for energy?

dependent ______

independent ______

WHAT'S THE PROBLEM?

TABLE A

***World Oil Reserves (in billion barrels)**

	non-OPEC	OPEC
Cumulative production to date (1976)	152	139
Remaining proven reserves	105	450
TOTAL	257	589

*Not including communist countries

1. What does "OPEC" stand for? ________________________________
____

2. Who has produced more oil to date, the OPEC nations or the non-OPEC nations? ____________________

3. Which group has the most remaining proven reserves? __________

4. The world is presently using 45 million barrels of oil per day. According to the table above, we have 555 billion barrels of oil reserves. At the present rate of consumption, how long will this reserve last?

STEP 1. Present use is 45 million barrels per day.

```
  365 days per year
x  45 million barrels per day
      million barrels per year
```

STEP 2. Divide your answer from Step 1 by 1000.

Your answer for Step 2 = ____________

This is how many billion barrels of oil we use per year.

STEP 3. Known reserves = 555 billion barrels

Divide 555 by your answer for Step 2.

$\text{answer to Step 2}\overline{)\,555} =$ ____________

This is the number of years before we use up our known reserves of oil!

STEP 4. How old will you be when we run out of oil?

____

5. Nebraska produces 6 million barrels of oil every year. This is enough oil to fuel the United States for 8 hours! Most of the oil production in Nebraska takes place in the western part of the state.

5. (cont)

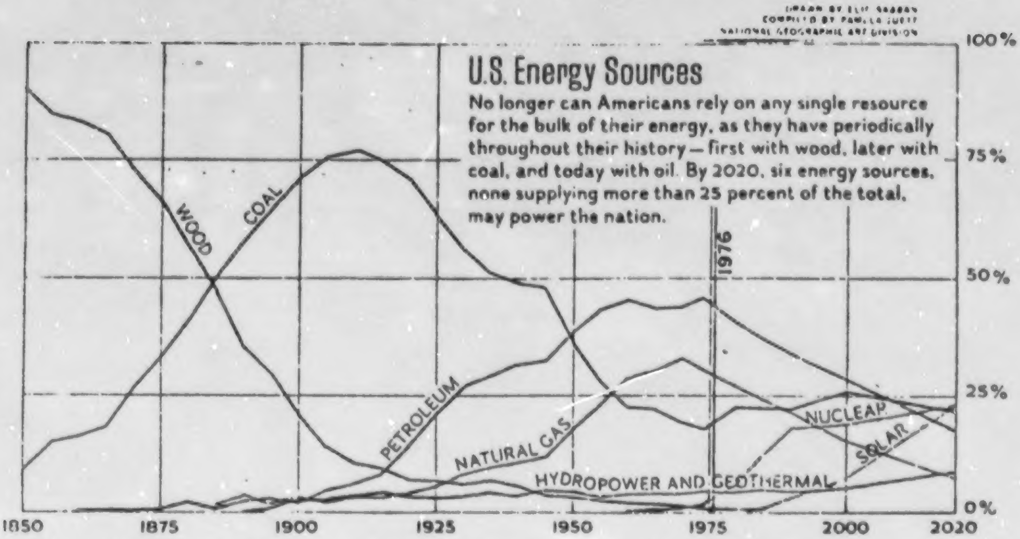
Nebraska uses 41 million barrels of oil per year. Since Nebraska only produces 6 million barrels of oil per year, how many barrels per year must Nebraska import? ______________________________

6. Oil costs about $13.80 per barrel. How much does the oil Nebraska imports cost? (13.80 x your answer for the question above)

____

7. The United States imports 10 million barrels of oil per day. For extra credit, figure how much the United States is spending each day for imported oil.

PAST, PRESENT, AND FUTURE: THE ENERGY PICTURE



U.S. Energy Sources

No longer can Americans rely on any single resource for the bulk of their energy, as they have periodically throughout their history—first with wood, later with coal, and today with oil. By 2020, six energy sources, none supplying more than 25 percent of the total, may power the nation.

DRAWN BY [illegible]
COMPILED BY [illegible]
NATIONAL GEOGRAPHIC ART DIVISION

1. In 1850, what was the major source of energy in the U.S.? ________

2. When did the use of coal as an energy source in the U.S. reach its highest percentage level? ____________________

3. In 1960, what was the major energy source in the U.S.? __________

4. In 1976, what were the six sources of energy in the U.S.? Please list them in order from highest use to lowerst use.

   1. ____________________
   2. ____________________
   3. ____________________
   4. ____________________
   5. ____________________
   6. ____________________

Does this list look familiar? The pie graph on energy sources which we studied earlier gives you the same information as this line graph. The pie graph shows what happened in a single year while this line graph shows what happened over a number of years.

5. This graph predicts that by the year 2020, four of the energy sources will be used almost equally in the United States. What are these four sources? ________________________________

   ____

6. Do you think dividing energy usage among these four sources, at these levels, is wise? __________

Why or why not? If you don't believe we should divide energy usage among these four, what source or sources do you believe

6. (cont).

we should be using in the year 2020? ______________________________

____

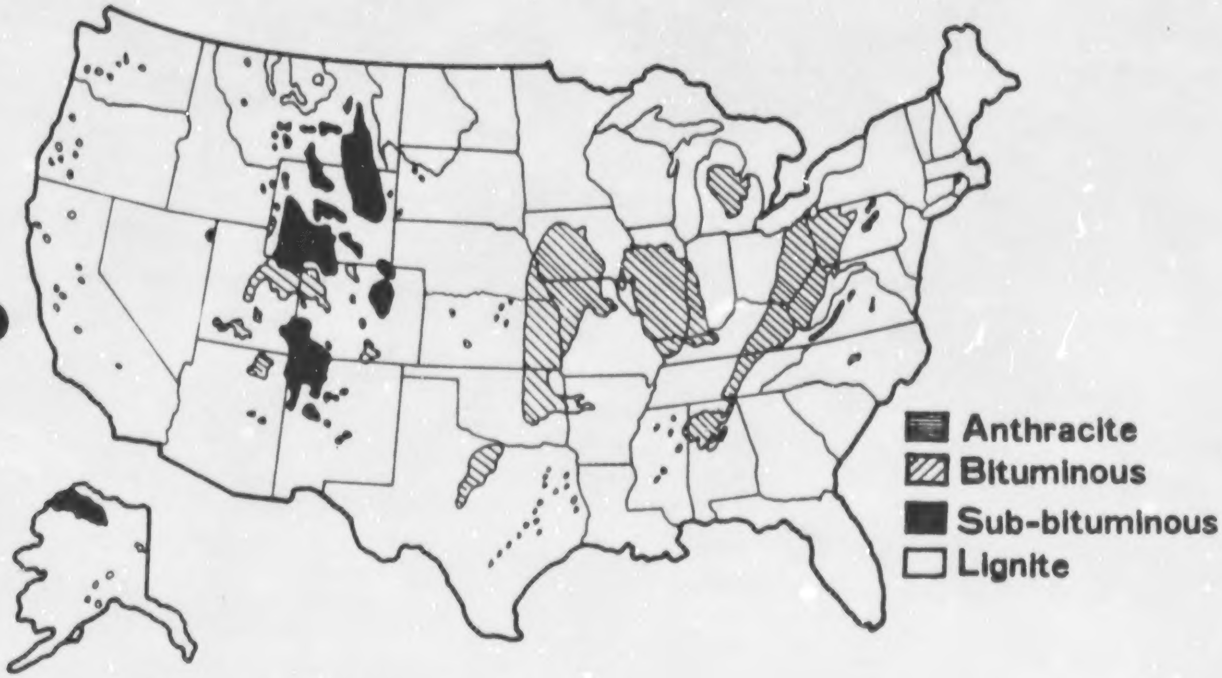
____

____

____

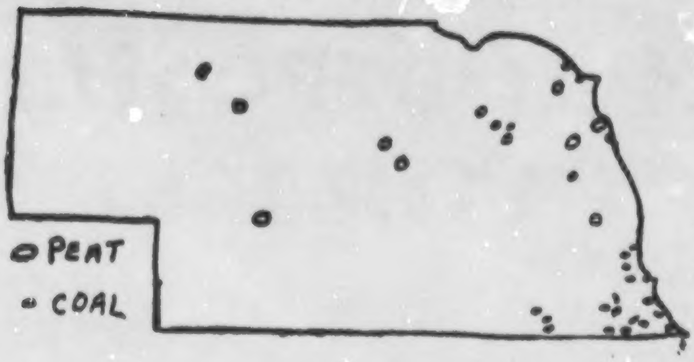
____

COAL DEPOSITS IN THE U.S.


▨ Anthracite
▨ Bituminous
■ Sub-bituminous
☐ Lignite

ANSWER THE FOLLOWING QUESTIONS:

1. Does Nebraska have any coal deposits? __________
2. Is the east coast of the U.S. rich in coal? ____________
3. Does the west coast of the U.S. have any coal deposits? _______
4. Which states in the west have large coal deposits? ____________
____
5. What type of coal is found in the eastern part of the U.S.?
____



OCCURRENCE OF PEAT AND COAL AT OR NEAR THE SURFACE

(From Mineral Resource map of Nebraska, Nebraska Georlogical Survey)

Use the map above to check the following statements True (T) or False (F)

____ 6. Most of Nebraska coal deposits are in the western panhandle of the state.

____ 7. Most of Nebraskas peat reserves are in the northeastern part of the state.

____ 8. Most of Nebraska's coal deposits are in the southeastern part of the state.

---

*WORLD COAL RESERVES
(Billion metric tons)

USA	396
Western Europe	225
USSR and Eastern Eurpose	349
CHINA	201
Rest of the world	143
	1314 Billion metric tons.

Use the above table to check the following statements True (T) or False (F)

____ 9. The U.S. has the greatest known reserves of coal.

____ 10. Western Europe has more coal than the USSR of Eastern Europe.

____ 11. Coal reserves in China are less than coal reserves in the U.S.

* From the report of the workshop on alternative energy strategies, 1977.

SOME FACTS ABOUT COAL

Decide whether each of the following facts is a problem (P) or an opportunity (O). Put a P or an O -- or both -- in each blank. On the bottom of this sheet, write down ways some of the problems could be overcome. Compare ideas with your classmates.

_____ 1. 90% of U.S. fossil fuel reserves (coal, oil, natural gas) are coal.

_____ 2. Some deep mines are dangerous.

_____ 3. 50% of our mineable coal is in the western U.S.

_____ 4. We have enough coal to last for 350 years, at current level of use.

_____ 5. Mining coal can cause damage to the environment.

_____ 6. In the future, we will rely more on coal as a source for synthetic oil and gas.

Activity from "The Energy Challenge", Federal Energy Administration

NATURAL GAS

Read the following items; then see if you can determine how long our natural gas resources might last.

ITEM 1: During 1975, the U.S. produced for use about 20 trillion cubic feet of natural gas.

ITEM 2: Our proven reserves at the end of 1974 were 240 trillion cubic feet.

ITEM 3: Fairly certain reserves of natural gas are about 202 trillion cubic feet.

If this amount of domestic natural gas was all the supply we had, it would last about how many years? (Add Item 2 and Item 3, and then divide by Item 1. Put the answer in this space).

______________number of years.

ITEM 4: The highest estimate of undiscovered natural gas resources is 655 trillion cubic feet.

If this amount is true, about how many years might our supply of natural gas last? (Add Item 2 and Item 3 and Item 4, then divide by Item 1. Put the answer in this space.)

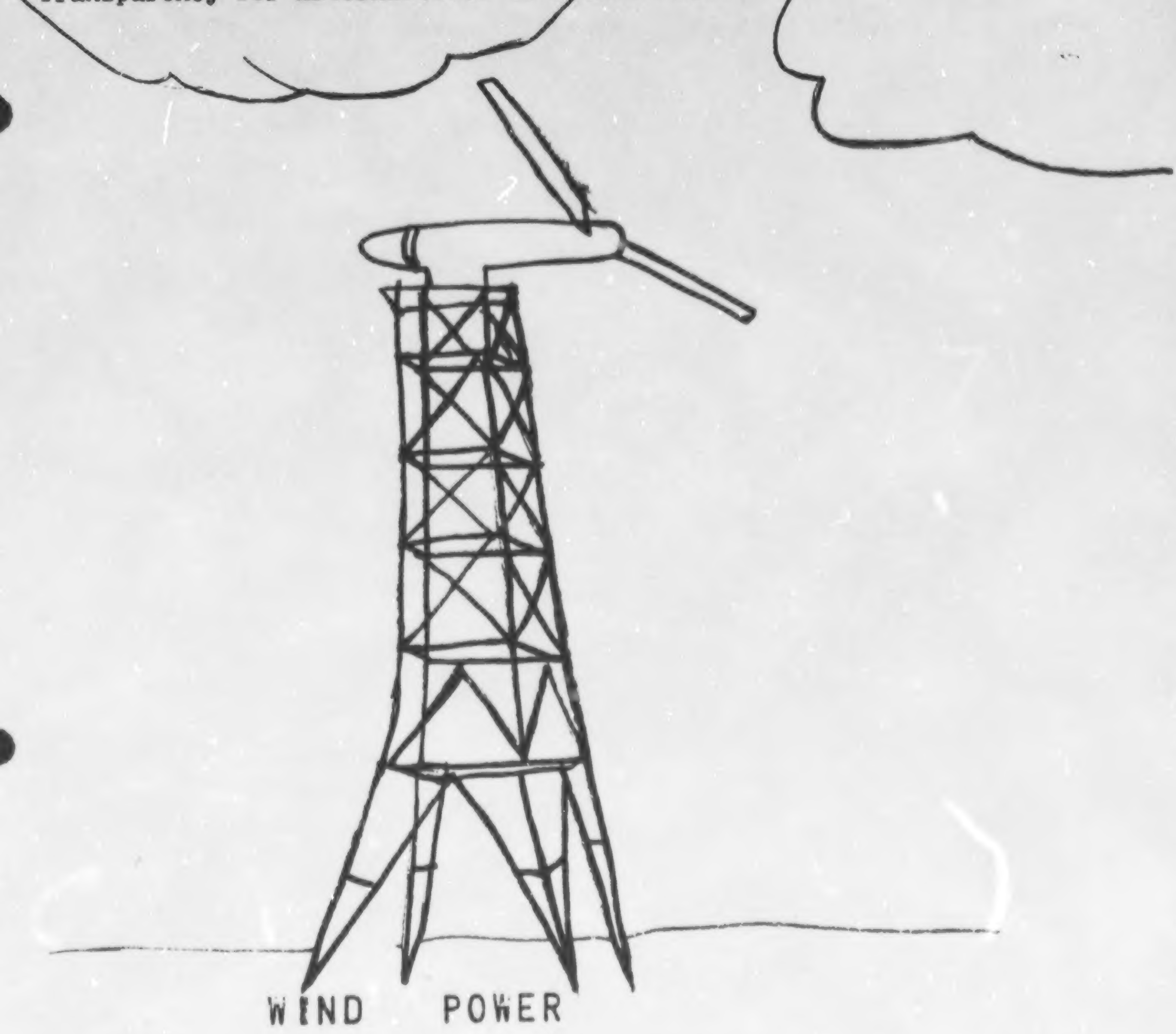
________________number of years.

At what time in your life could the U.S. run out of natural gas?

____

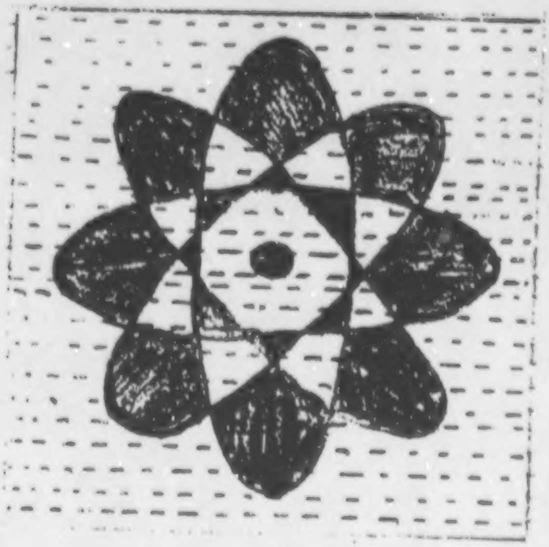
Adapted from "The Energy Challenge" Federal Energy Administration

Transparency for Alternaitives to Fossil Fuels



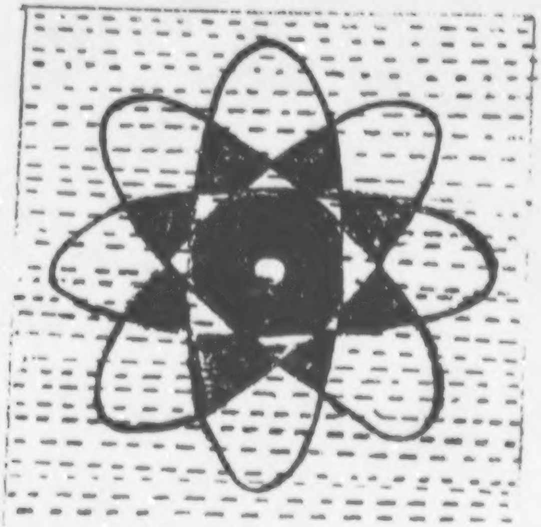
Transparency for Alternatives to Fossil Fuels

NUCLEAR ENERGY



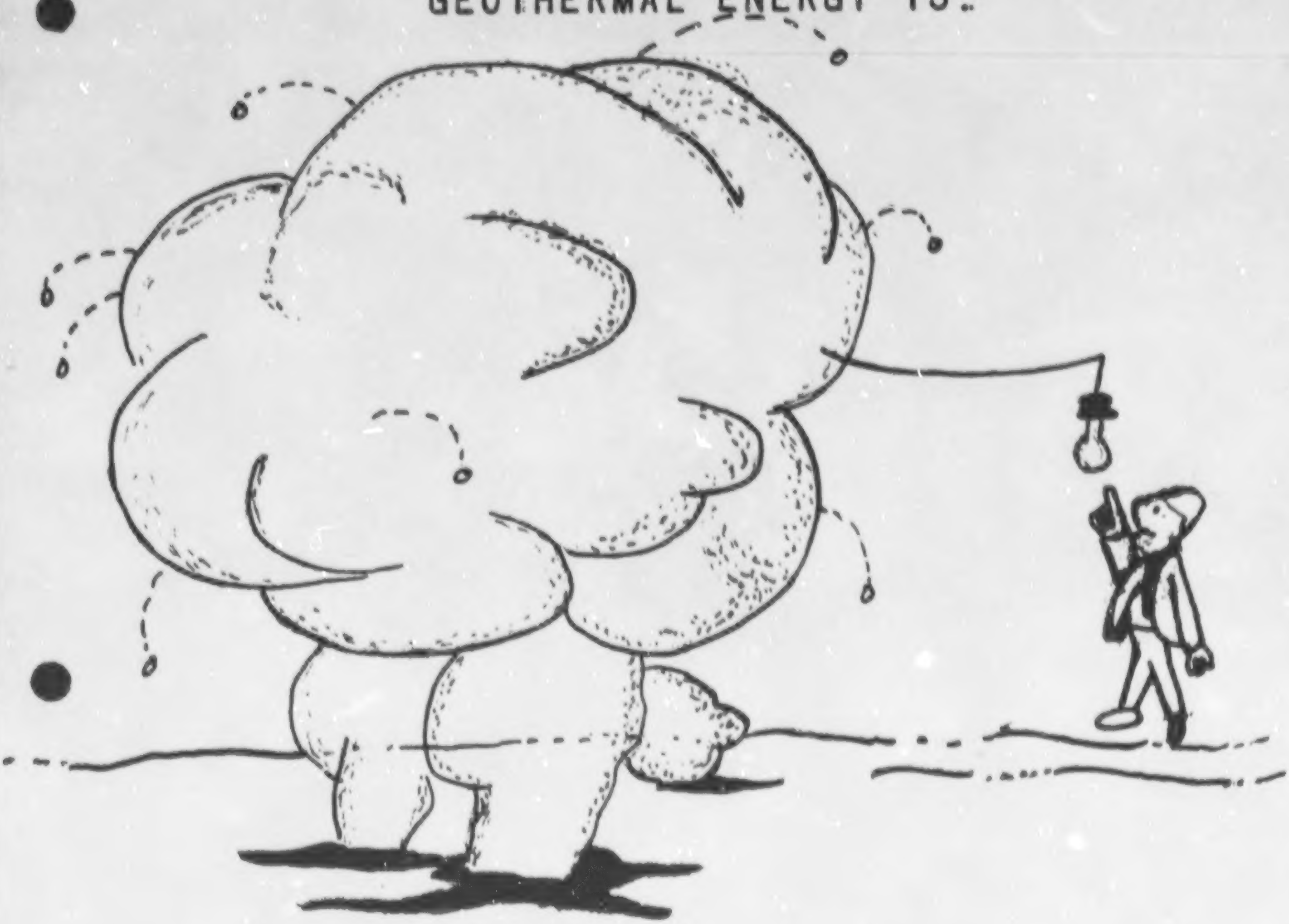
FUSION IS:

FISSION IS:



Transparecny for Alternatives to Fossil Fuels

GEOTHERMAL ENERGY IS:



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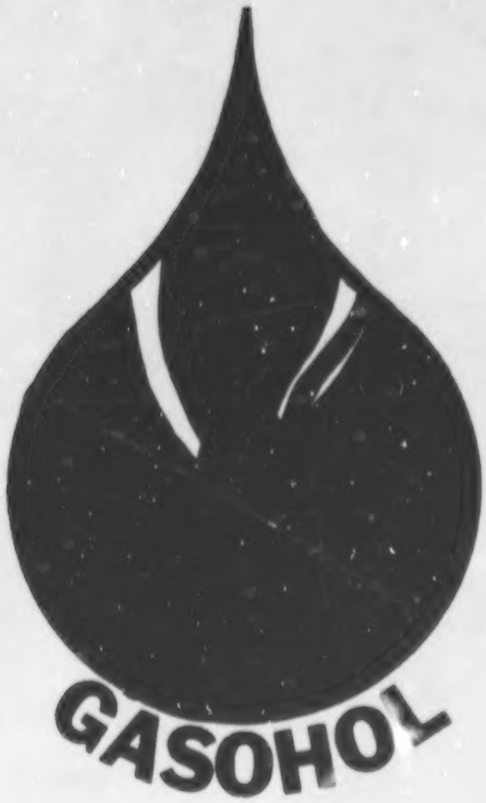
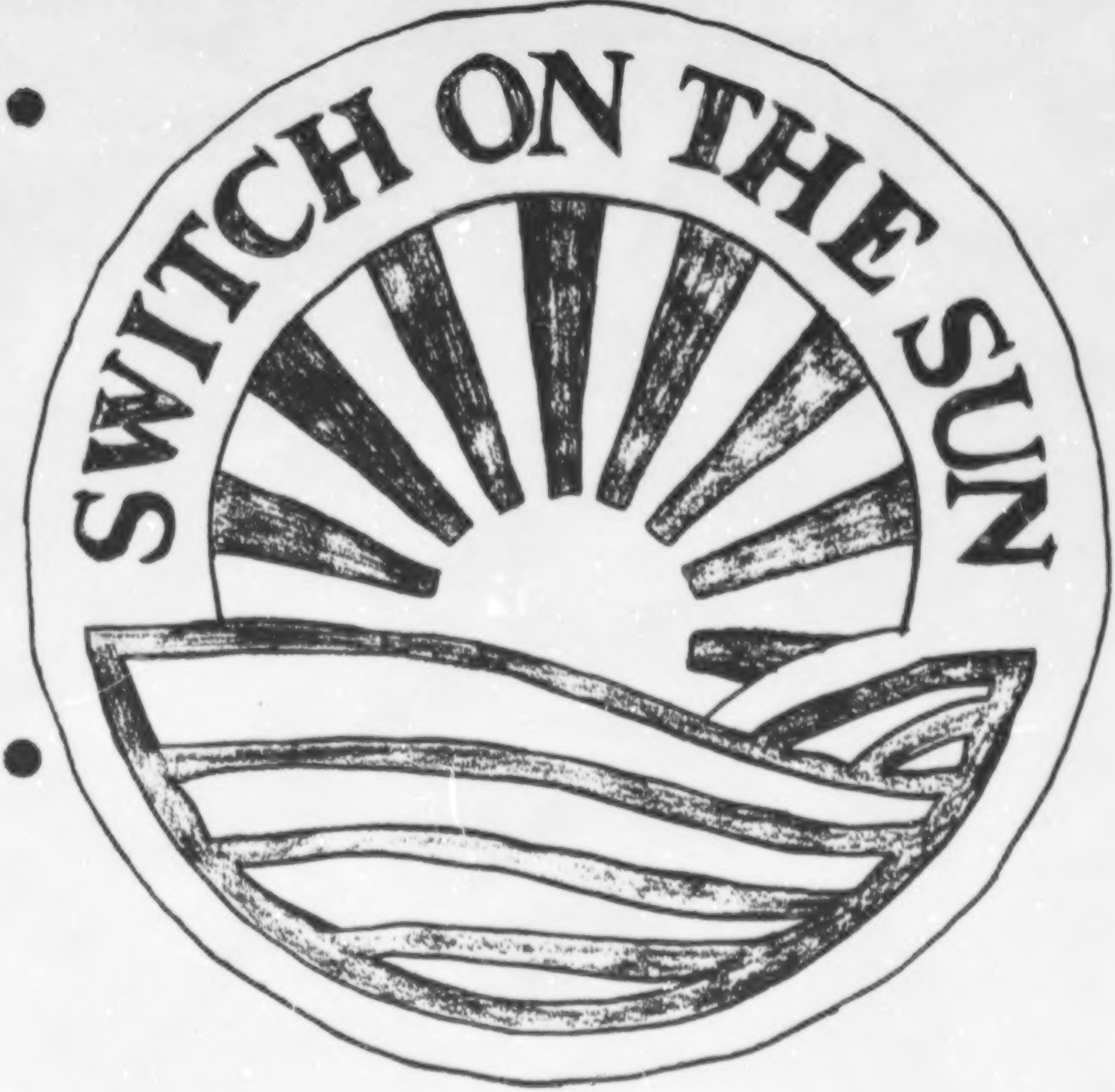
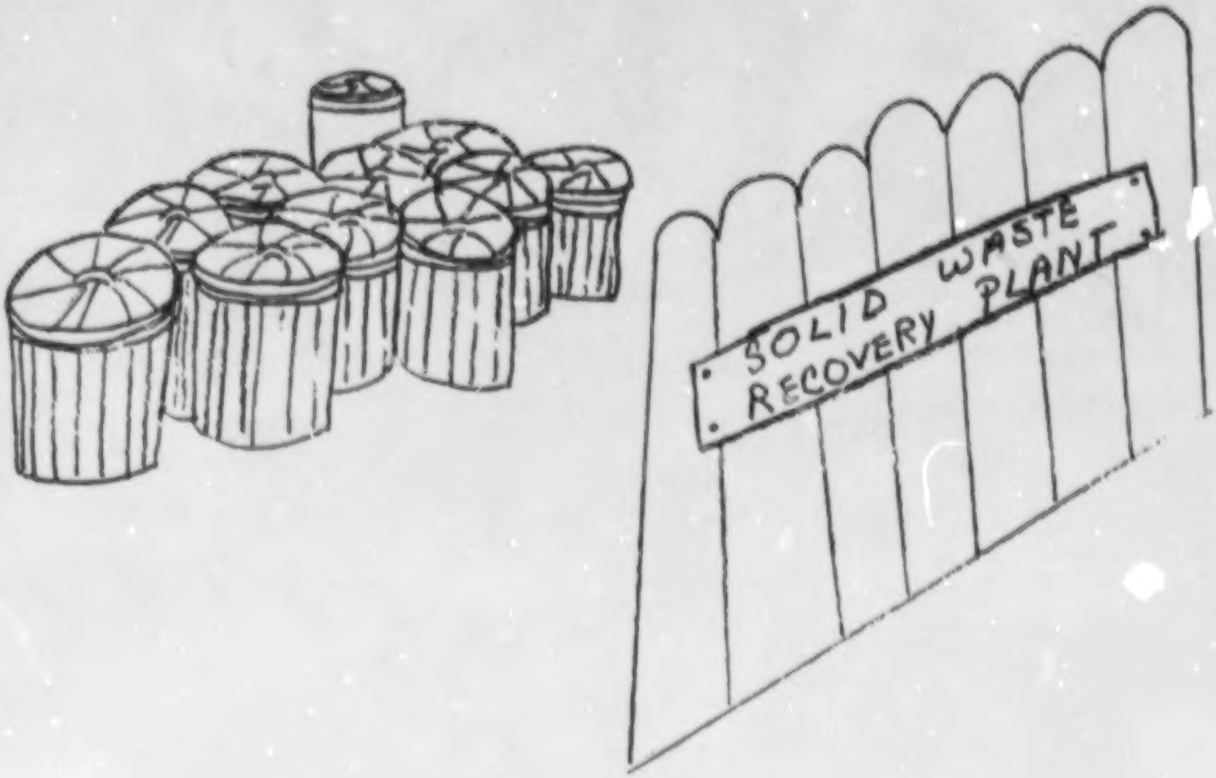


Transparency for Alternatives to Fossil Fuels


SWITCH ON THE SUN

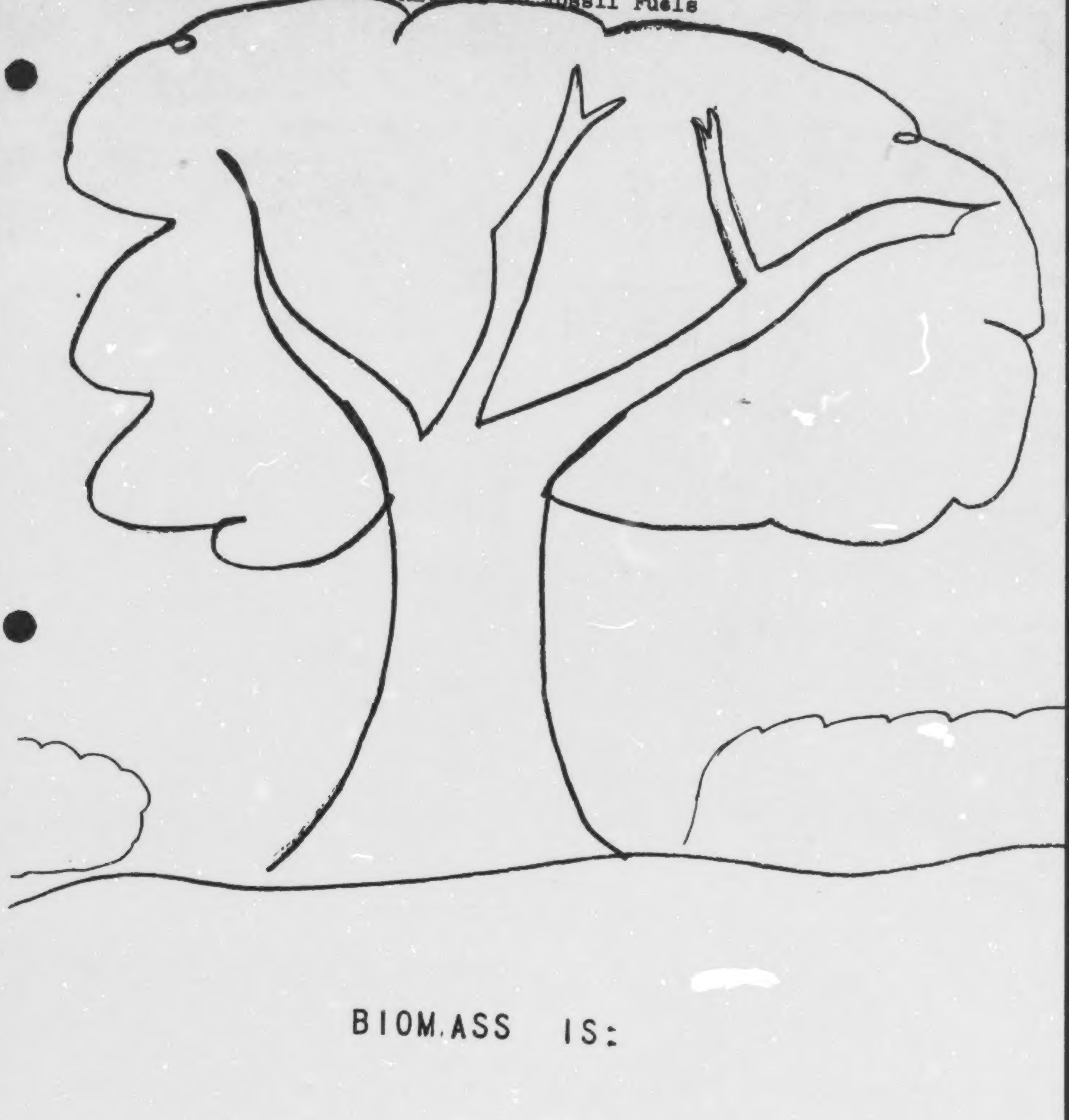
SOLAR ENERGY IS:

Transparency for Alternatives to Fossil Fuesl


SOLID WASTE RECOVERY PLANT

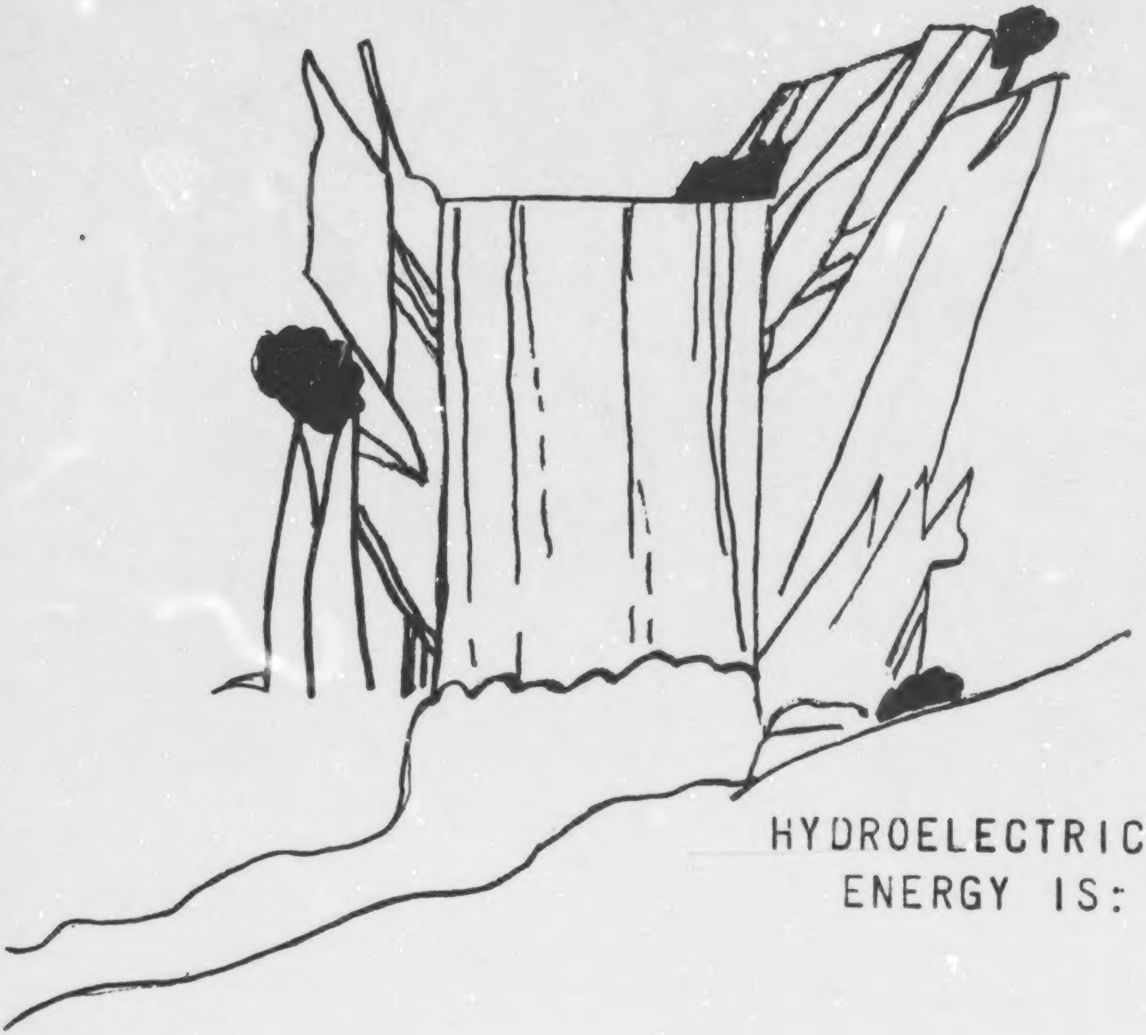
SOLID WASTE RECOVERY IS:

Transparency for Alternatives to Fossil Fuels



BIOMASS IS:

Transparency for Alternatives to Fossil Fuels



HYDROELECTRIC
ENERGY IS:

ENERGY GLOSSARY

1. atom - the basic building block of all matter, the smallest particle of a chemical element that still has the properties of that element.

2. barrel - a commonly used measurement for oil. It equals 42 gallons. One barrel of crude oil has the same energy as 350 pounds of coal.

3. BBD - abbreviation for billion barrels per day.

4. biomass - any renewable plant material that can be used to generate energy. Examples include: algae, silage, wood and fermentable grains.

5. breeder reactor - a nuclear reactor that makes more nuclear fuel than it uses, by changing certain atoms that will not split into atoms that will split.

6. BTU - abbreviation for British Thermal Unit. This is the amount of heat necessary to raise the temperature of one pound of water 1 degree Fahrenheit.

7. calorie - a metric unit of heat energy. This is the amount of heat necessary to raise the temperature of one kilogram of water 1 degree Celsius.

8. chain reaction - a reaction that stimulates its own repetition. Example: fission

9. coal - a solid fuel, mostly formed from the fossils of plants living hundreds of millions of years ago.

10. conservation of energy - more efficient use of both existing and new sources of energy.

11. crude oil - petroleum as it comes from the ground. It is formed from the fossils of animals and plants at the bottom of ancient seas.

12. deep mining - mining that must be performed by digging underground shafts and tunnels.

13. depletion allowance - a tax reduction granted to companies engaged in extracting oil, natural gas, and other minerals. It is based on the idea that these resources are exhaustible and, therefore, the companies are depleting their own sources of future income.

14. efficiency - the ability to produce a desired effect with a minimum of effort, expense, or wastes.

15. energy - the ability to do work. Work, in this sense, is any change in the state of an object.

16. fly ash - tiny particles of solid ash in the smoke when fuels such as coal are burned.

17. fluorescent - able to glow with visible light when hit by ultraviolet or other radiations.

18. First Law of Thermodynamics - Energy can be neither created nor destroyed.

19. fission (nuclear) - the splitting of the nucleus or center of one atom into two or more smaller atoms. Fission often releases large quantities of energy.

20. fossil fuel - any fuel formed from the fossils of plants and animals. Examples are: coal, petroleum and natural gas.

21. fuel - any material burned to supply heat or power.

22. fuel oil - a refined petroleum product.

23. fusion (nuclear) - the process of combining the nuclei or centers of two light atoms to form a heavier atom. Fusion can release great quantities of energy. The sun produces its energy by fusion.

24. gasohol - a mixture of 90% unleaded gasoline and 10% anhydrous grain alcohol.

25. geothermal energy - heat energy in the earth's crust whose source is the earth's moten interior.

26. hydroelectric plant - an electric power plant in which the energy of falling water is converted to electrical energy by a turbine generator.

27. incandescent - glowing hot enough to give off light.

28. kilowatt - a unit of electric power (1000 watts) indicating the rate at which electrical energy is being produced or consumed.

29. mass transit - any form of public transportation that carries large numbers of people.

30. MBD - abbreviation for million barrels per day.

31. natural gas - a gaseous fuel formed from the fossils of ancient plants and animals. This gas is often found with crude oil.

32. nuclear power - the energy produced by splitting atoms (such as uranium) in a nuclear reactor.

33. nuclear reactor - fissionable fuel assembled and arranged to sustain a fission (atom-splitting) chain reaction.

34. nuclear wastes - used fuel from a nuclear reactor. This used fuel is highly radioactive.

35. oil - the term commonly used for the liquid form of petroleum.

36. oil shale - a deposit of shale rock that contains petroleum.

37. OPEC - abbreviation for the Organization of Petroleum Exporting Countries. These countries are mainly from the Middle East and Africa. These nations produce more than half of the world's oil, and supply about 85% of the oil imported by non-member nations. OPEC has a major influence on petroleum pricing and supply.

38. petroleum - fuel formed by the fossil remains of plants and animals.

39. primary energy source - a source of energy that can be used in its naturally occurring form. Examples include coal, uranium and oil. These fuels do not have to be converted to another form before they can be used.

40. radioactivity - a spontaneous change in the nucleus or center of an atom, accompanied by the release of energy called nuclear radiation.

41. renewable resources - a resource that will not be depleted after use either because it is constantly available (such as sunlight, wind or water flow) or because it can be reproduced (such as wood).

42. reserve - the portion of a resource that has been actually discovered but not yet used which is presently technically and economically extractable.

43. solar energy - energy received from the sun. NOTE: Nuclear and geothermal are the only presently available energy forms not derived from the sun.

44. solid waste - all useless, unused, unwanted or discarded solid materials.

45. strip mining - mining for coal or useful ores by removing the soil and rock found above them, rather than by tunneling underground.

46. wind energy - power generated from a rotor blade pushed by winds.

ENERGY: YESTERDAY, TODAY AND TOMORROW

Unit #2

FUELIN' AROUND WITH FUELS--SCIENCE ENERGY ACTIVITIES

by

Susan Pierce	Richard W. Lourien
Nikki J. Scott	Patty Kondo
Dianne J. Kennedy	Geri J. Imel

Prepared for
the Nebraska Energy Office

To the Teacher:

The purpose of this science unit is to allow students to experiment with actual fuels. Since experimentation is such a fundamental component for learning, this unit is laboratory-centered. Students will be able to collect solar energy, gain an understanding of nuclear energy and see some of the problems associated with the use of coal. Following the introductory and science packets, students should be able to form some opinions about the energy situation. Discussion after each lab is, therefore, important.

The length of time for each lab and activity is:

1.	Energy Technology	1/2 day
2.	Fuelin' Around with Fuels	1/2 day
3.	Collection Methane Gas	1/2 day prep.
4.	Determining the Heat Content of Oil	1/2 day conclusion
5.	Ashes, Ashes, Everywhere!	1 day
6.	Gas from Grain	1 day prep.
7.	Collecting the Sun's Energy	1 day
8.	Designing a Solar Home	2 days
9.	Creating a Collector	1 day
10.	Nuclear Energy	1/2 day
11.	A Chain Reaction	1/2 day
12.	Nuclear Puzzle	1/2 day

Before beginning the units, you will need to acquire the following materials:

1. Energy Pamphlets (May be ordered from Nebraska Energy Office P. O. Box 95085, 301 S. Centennial Mall, Lincoln, NE 68509)
   "Energy Technology"
   "Nuclear Energy"
   "A Summary of Gasohol" (May be ordered from Agricultural Products Industrial Utilization Committee, 301 S. Centennial Mall 3rd Floor, Lincoln, NE 68509)

2. Supplier for testing fuels (See Fuelin' Around with Fuels lab).

3. Fiberglass Insulation.

4. Metal cans, orange juice cans with metal bottoms, quart jars.

5. Screen wire

6. Coal samples

7. Laxative pills with phenthathalium

8. Charcoal, coal and fireplace ashes

9. White bar soap

10. Solar Cells (May be ordered from: Edmund Scientific Berryinton, New Jersey -- they are approximately 50¢ each).

11. Motor with spinner disc

12. Lamp with 100 watt bulb

13. Boxes, shoe size or bigger

14. White paint

15. Plastic wrap and aluminum foil

16. Old newspapers

17. Dominos

All other materials needed should be available in the science class room.

FILM: The following films are excellent. We highly recommend that they be used during the unit. Although they are high level films, we believe they are the best available at this time.

"To Meet The Challenge" (nuclear) (16mm film)

Available from Nebraska Public Power District
1414 - 15th Street
P. O. Box 499
Columbus, NE 68601

"Energy Alternatives" (solar geothermal) (16mm film)

Lincoln Public Schools
Public School Administration Bldg.
Lincoln, NE 68521

"Gasohol-Slide Show"

Ag. Products IIC
301 S. Centennial Mall
3rd Fl. State Office Bldg.
Lincoln, NE 68509

Energy Technology
Review:

1. In your own words define the word fuel. ____________________
____
____

2. Machines, cars and tractors must use a fuel such as gasoline when they do work. Even animals and people need fuel in the form of food in order to do work. Look up a definition for the word "energy". (Use any science text, glossary or dictionary). "Energy" is: ____
____

The use of some form of fuel is often necessary to produce energy. ____________________ is one energy source.

3. List 10 daily activities that require energy or the expenditure of some kind of fuel.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

4. Now read "Energy Technology" to review the various energy sources. List all the energy sources available to man.

5. Beside each energy source, put an "F" if the use of fuel is required and put an "E" if the energy source exists due to the sun and earth's own potential.

6. Find a definition for renewable: ____________________________
____

7. Now decide what the term "non-renewable" must mean: __________
____

Go back to the list of fuel sources and put an "R" beside each renewable energy source and an "N" beside the nonrenewable energy sources. Think carefully about each one!!!!

8. Look back at the list of energy sources and the notations you have made. Complete the following using the words "renewable" and "non-renewable" and your own conclusion.

a. Energy sources that require the use of a fuel are

________________ energy sources.

What will eventually happen to these sources? ____________

____

____

b. Energy sources that exist freely due to the sun and earth's potential are ______________________ energy sources.

Will these sources ever be used up? ____________________

9. Look at the list of energy sources agian. Put a "T" by those sources that we use the most today. Are our current popular energy sources mostly renewable or non-renewable?

10. What will eventually happen if we continue or increase our use of these energy sources?

Can you make any suggestions that will help insure adequate power for the future?

Fuelin' Around With Fuel

I. Fuel is any material burned to supply heat or power. Below is a list of things which may or may not be fuel. Run a test to see which are fuels. Place a check beside each item that is a fuel.

1. paper ______
2. potato chips ______
3. charcoal ______
4. rock ______
5. fabric ______
6. aluminum foil ______
7. plastic ______
8. metal ______
9. glass ______
10. toothpicks ______
11. dried plant ______
12. alcohol ______
13. cardboard ______

II. Doing the test:

You will need:
1. a candle or burner
2. a pair of tweezers
3. a sample of each of the items listed above

Procedure:
1. Get materials to be tested.
2. Pick up the material one at a time with the tweezers.
3. Place the material in a burning flame. **If you test a liquid, dip a piece of aluminium foil in the liquid and proceed with the test.
4. Observe the materials.
5. Repeat with a second material.

III. Choosing a fuel:

List the fuels below that you think are good fuels.

List one reason why you choose these fuels as "good" fuels.

IV. Conclusion:

From the data you have collected, write any conclusions you can make about fuels.

V. Bring 2 materials from home. Test your samples to determine if each is a fuel.

Sample 1 ________________
Sample 2 ________________

OIL: BRIGHT PROMISE (Science)

HEAT CONTENT OF OIL
(Student Hand-Out I)

Purpose To determine the heat content of oil.

Materials

Fiberglass insulation
Glass stirring rod
Bunsen burner(1 pr. lab group)
Ring stand with clamp
Thermometer (40^{0}-150^{0}C)
8 oz. juice can with metal bottom
16 oz. metal can
3-in-1 oil
Platform balance
Screen wire
Scissors
Matches
Data sheet

Procedure

1. Weigh 100 ml. of water and pur in juice can. Record on data sheet.

2. Read the temperature of the water. Record it on data sheet.

3. Make a small stand out of the piece of wire screen.

4. Cut a piece of fiberglass insulation about 2.5-3 cms. in width and length.

5. Place the small wire screen and fiberglass insulation on the platform balance.

6. Slowly drip 20-22 drops of 3-in-1 oil onto the fiberglass. Record the mass of the screen stand, fiberglass and 3-in-1 oil on data sheet. (Weight should be about .3 gms. or .003 Kg.)

7. Use a beer can opener to put holes in the sides of the larger can as shown in diagram.

8. Remove the bottom from the larger can.

9. Using your scissors, punch a small hole in the top (sides) of the small juice can for the stirring rod. Insert stirring rod.

10. Now remove the wire screen, fiberglass and oil from the balance.

11. Leaving the fiberglass on the wire screen, ignite the oil.

12. Raise the large can and cautiously push the burning oiled fiberglass under the juice can containing the water.

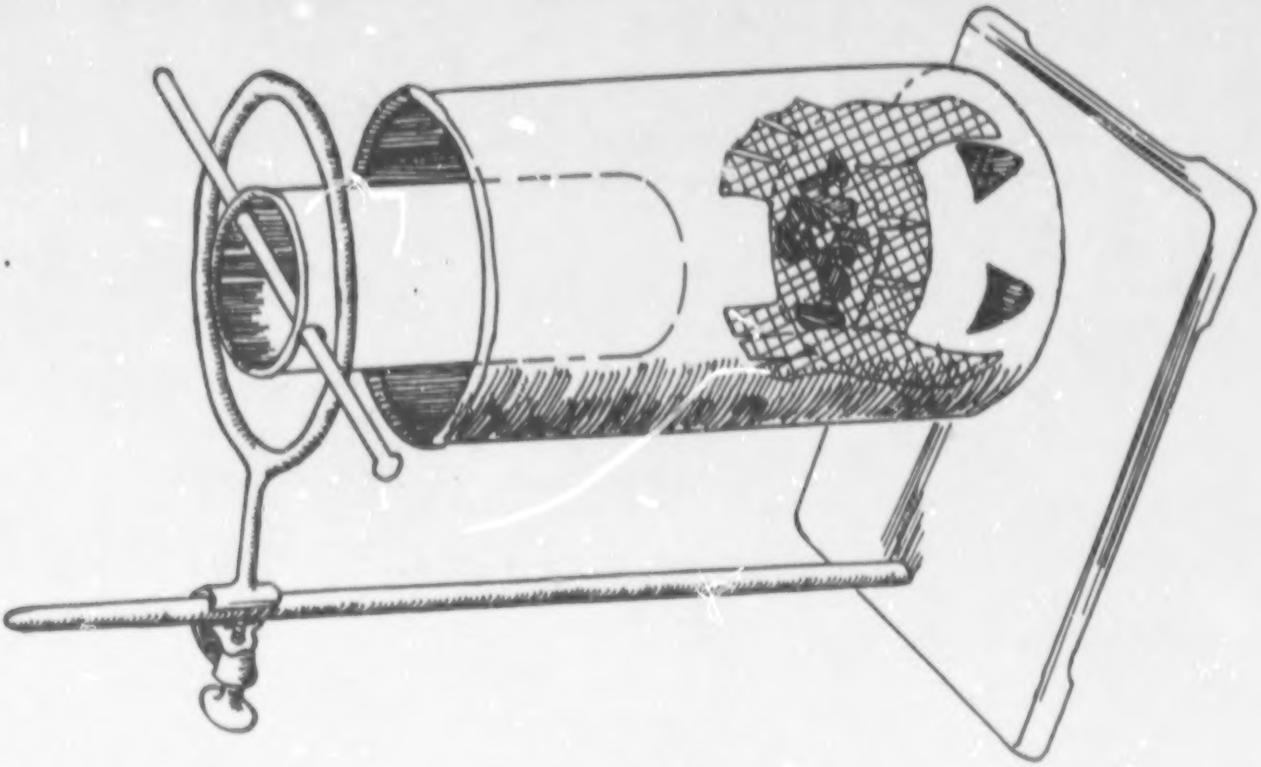
13. Lower the large can over the burning oiled fiberglass.

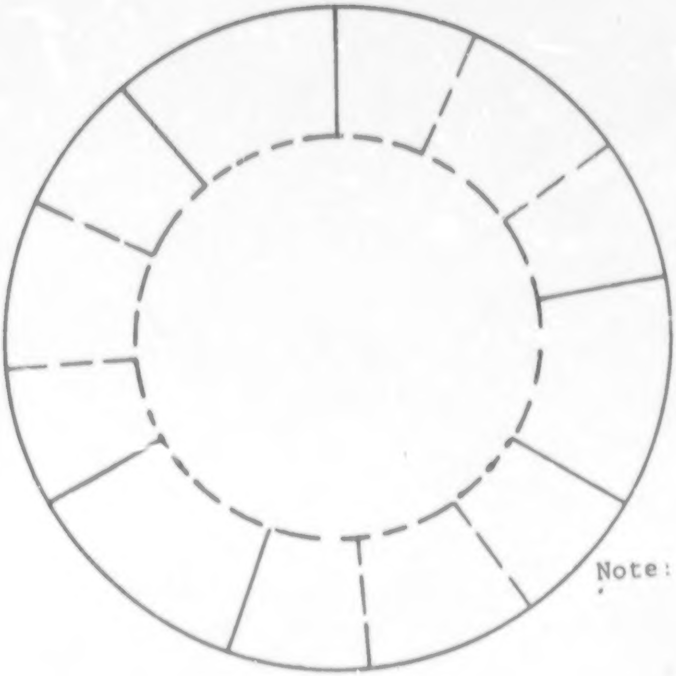
14. After the oil has burned off the fiberglass, record the temperature of the water on the data sheet.

15. Cautiously raise the larger can and remove the wire screen containing the unburned fiberglass. Weigh the screen and fiberglass to see if you burned all the oil that you started out with.

16. Determine the heat content of oil. See data sheet.

*Note to teacher: This makes a good class demonstration if only one burner is available.





Note: Cut along solid lines

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DATA SHEET

1. Mass of water ______ml = _____g or ______Kg

2. Temperature of water before heating _____°C

3. Mass of screen stand, fiberglass and oil before heating ______gms

4. Mass of screen stand, fiberglass and oil after heating _____gms

5. Mass of oil _______

6. Temperature of H_2O after heating _____°C

7. Change in water temperature _____°C

*8. Heat gained by water = temperature change x mass of water x 1 = _____Calories

9. Heat content of oil = $\dfrac{\text{Heat output (Heat gained by } H_2O\text{)}}{\text{Mass of oil}}$ = ______Cal/Kg

COLLECTING METHANE GAS

I. The mining of coal is a hazardous occupation because many mines have high concentrations of methane gas.

II. You will need:

1. Soft or bituminous coal
2. Funnel
3. Wide mouth quart jar
4. water
5. Test Tube
6. Rubber band

III. Procedure

1. Hammer the lumps of coal into a coarse powder.
2. Put the coal in the funnel.
3. Fill the test tube with water.
4. Place the stem of the funnel in the test tube, as illustrated below. (Diagram A)

Diagram A

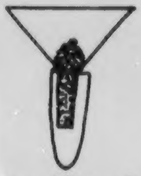
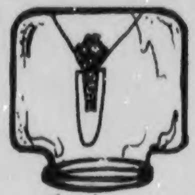
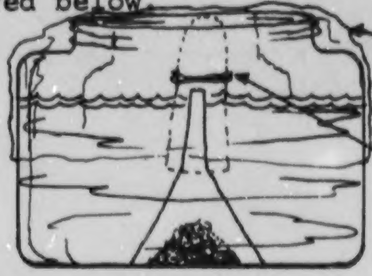


Diagram B



5. Place the funnel and test tube in the jar. (Diagram B)
6. Turn the jar right-side up and fill the jar quickly with water.
7. Mark the test tube at the water line with a rubber band.
8. Place a piece of plastic wrapping (cellophane) over the top of the jar to hold the test tube over the funnel stem.

9. You should now have a set-up similar to that pictured below.



Cellophane (used to hold funnel in place)

Rubber Band around test tube. (Test tube should be filled with water to this point).

10. Set jar aside for 2 days.

11. In 2 days, remove the test tube and put your thumb over the top.

12. Light a match and turn the test tube upright. Remove your thumb from the test tube.

IV. Observations.

V. Conclusions.

VI. Bonus: Why is mining a gengerous occupation? (Hint: Do some research on the effect of methane gas).

ASHES, ASHES, EVERYWHERE!

I. One of the problems with burning wood and coal is disposing of the ashes. Let's investigate to see how much of a problem this might be.

II. You will need:

1. 2 laxative pills that contain phenolhthalein
2. ashes from coal, charocaola, fireplace
3. cup rubbing alcohol
4. spoon and saucer
5. glass jar with lid
6. white bar soap
7. baking soda, vinegar, ammonia

III. Procedure:

1. Crush laxative pills with back of spoon
2. Add alcohol
3. Pour alcohol into glass jar; leave sediment in the saucer.
4. Test the soap, baking soda, vinegar and ammonia by adding a drop or two of the alcohol solution.

Record any color change:

Material	Color Change	Alkaline or Acid
A. Soap		
B. Baking Soda		
C. Vinegar		
D. Ammonia		

5. Repeat the experiment using fireplace ash, coal and charcoal. Chart your results on the above chart.

IV. Conclusions:

1. Of all the ashes tested, which gives a stronger color change?

   ____

2. What conclusions can you make from these results?

GAS FROM GRAIN

1. Look back to the first lab we did. What liquid was a good fuel?

Scientists, in an effort to conserve our fossil fuels, particularly gasoline, have combined two good fuels, alcohol and gasoline, to create a new fuel alternative--gasohol. Gasohol is made by combining 90 gallons of gasoline with 10 gallons of ethyl alcohol. The ethyl alcohol is a fuel that we can literally "grow" in Nebraska. It is made by the fermentation of grains. First, the grain is cracked, cooked and then an enzyme called "amylase" is added. Amylase breaks down starches in the grain into sugar. Yeast is then added to break down the sugar into alcohol and a colorless gas called carbon dioxide. This chemical reaction shows what happens during the production of gasohol.

Step One: $\underset{\text{Starch}}{C_6H_{10}O_5} + \underset{\text{Water}}{H_2O} \xrightarrow[\text{Amylase}]{\hspace{6em}}$ (sugar)

Step Two: $C_6H_{12}O_6 \xrightarrow[\text{Yeast}]{\hspace{4em}} \underset{\text{alcohol}}{2\ C_4H_5OH} + \underset{\text{carbon dioxide}}{2\ CO2}$

Step Three: 1 part alcohol + 9 parts gasoline = gasohol

2. How could the use of gasohol, 90% gasoline, 10% alcohol, help to conserve gasoline reserves?

3. Gasoline, a fossil fuel, is a _______ (renewable or non-renewable resource. Ethyl alcohol is a ________ energy source.

4. To see how ethyl alcohol can be made from grain, you can do this experiment.

Materials: cracked grain or corn meal, added to water, cooked for 5-10 minutes and cooled to room temperature; a test tube; saliva; yeast; and a baloon.

*Fill a test tube 1/2 full of a mixture of cracked grain and water that was cooked and cooled by the teacher.

**Amylase must now be added. This enzyme can be found in your saliva. It will break the starch in the grain into sugar. Add amylase from your saliva to the grain in the test tube and let set overnight.

***The next day, add a pinch of yeast and seal the top of the test tube with a balloon. The yeast will convert the sugar into alcohol and carbon dioxide.

****Wait a day or two. What 2 reactions tell you that fermentation has occured?

a. What 3 substances are needed to generate sugar?

   1) In the lab you just completed, what starch did you use?

   2) What was your amylase source?

b. What products are generated when you added yeast to sugar?

c. What 2 reactions tell you that fermentation has occured?

Read: "A Summary--Gasohol" (Obtained from the Ag. Industrial Utilitilization Committee, 301 S. Centennial Mall, 3rd Floor, Lincoln, NE 68509)

5. What state started the gasohol research program?

6. Give three encouraging results from the Nebraska road tests of gasohol.

7. Gasohol does not have to be made of high quality food grains. It can be made of distressed grains. What are distressed grains?

   If not made into gasohol, what currently happens to distressed grains?

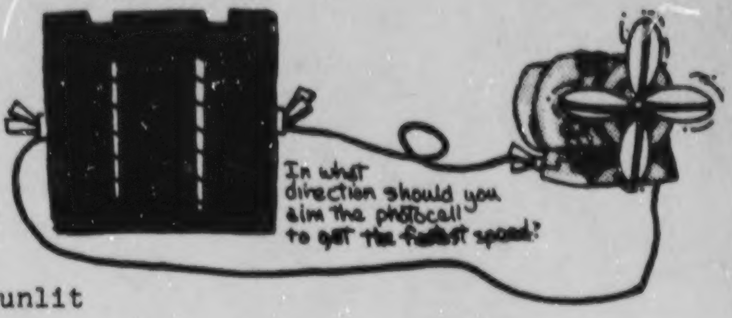
8. After grain is fermented to make gasohol, what can the leftovers be used for?

9. Besides helping to conserve fossil fuels, the production of gasohol can also help farmers. List two ways the development of gasohol as an industry can help Nebraska farmers.

Collecting the Sun's Energy

I. How close to a light bulb do you think you have to place a solar cell to make a motor run as fast as it does in sunlight? ________________ After you have made your prediction, do the following experiment to see how close you came to predicting the correct distance.

II. You will need:
1. solar cell
2. Motor with spinner disc
3. Lamp with 100 watt bulb


In what direction should you aim the photocell to get the fastest speed?

III. Procedure:
1. Connect the solar cell and the motor as shown in the diagram.
2. Aim the solar cell out a sunlit window and notice how fast the motor turns.
3. Now, hold the photocell near a 100 watt bulb out of sunlight.

IV. Conclusions:
1. How close does the solar cell have to be to equal the energy from the sun?
2. What happens if you use bulbs of different wattages?
3. What would happen if the bulb were in a reflector?
4. If you weren't allowed to move the solar cell during the day to follow the sun, what would be the best direction to aim it?

Designing A Solar Home

I. Construct a model home with different roof shapes, material of your choosing and color. You can also vary the window coverings. If you would like to you may begin by making a home like the following.

II. You will need:
   1. 2 Cardboard boxes of same size - shoebox size or larger
   2. White paint or paper
   3. 2 thermometers
   4. Plastic wrap
   5. Masking tape

III. Procedure:
   1. Cut a large hole in 1 side of 1 box and cover it with plastic wrap--tape tightly all the way around.
   2. Paint both boxes white, or cover them both with white paper.
   3. Place a thermometer in each box and put them in the sun.
   4. Record the temperatures after 10 minutes?____________
      20 minutes?_______________ 30 minutes?_______________
      Graph you results.

IV. Conclusions:
   1. What difference would it make if you did the experiment at different times during the day?

   2. Add an overhang to both boxes. Does this make any difference?

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CREATING A SOLAR COLLECTOR

I. Scientists and home builders have been designing homes to use the sun as a source of energy. Many homes are now heated with the aid of the sun, and a solar collector.

II. Procedure: Using the following materials, design a solar collector. A box, some newspaper, clear plastic wrap, aluminum foil, black paper, tape and thermometer.

III. After you complete your collector, place it in the sun. See which collector gets the hottest.

Nuclear Energy:

Read the pamphlet "Nuclear Energy" (may be obtained thru the Nebraska Energy Office).

1. State the major use of nuclear energy. ______________________

2. Our conventional power plants burn fossil fuels to make electricity. List two examples of fossil fuels.

   a. ____________________________________

   b. ____________________________________

   What fuel does a nuclear power plant use? ________________

3. The fuels to generate electricity, whether uranium or coal, are: (a) renewable or (b) non-renewable.

4. On which fuels do we now rely to produce our energy?

   ____

5. Give two reasons why some people suggest increased use of nuclear energy in the future.

   a. ____

   b. ____

6. A Chain Reaction:

   I. Since neutrons are so dangerous, we can't use them in school. However, we can use wooden blocks or dominoes to demonstrate how fission occurs.

   II. You will need:

      a. a flat surface (table top)

      b. several dominoes

   III. Procedure:

      a. Stand up the blocks in a row until you run out of blocks.

      b. When you finish, push the first block over.

   IV. Conclusion:

      a. Describe what happened?

      b. How can the action be stopped?

         How can the action be slowed down?

      c. In what ways are falling blocks like a nuclear reactor?

7. Do the authors of "Nuclear Energy" believe nuclear power is a safe and environmentally clean energy alternative?

____

Give 5 statements from the pamphlet designed to lead you to believe nuclear energy is a good energy alternative.

a. ____
b. ____
c. ____
d. ____
e. ____

8. Find an article from a newspaper or magazine that has a different point of view.

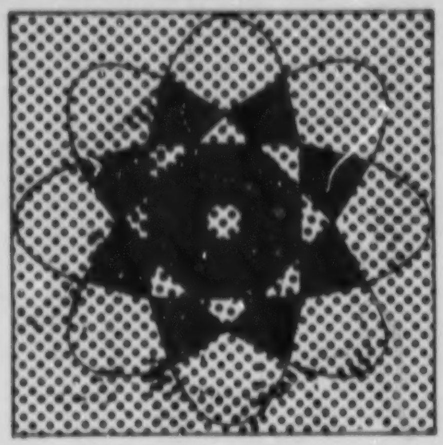
After reading both points of view, how do you feel about the use of nuclear power?

Puzzle--Fission or Fusion?

I. There are two ways we can use atoms to produce energy. The first way is called fusion. Fusion occurs when lots of smaller atoms come together to form a larger atom.

The second way is called fission. Fission occurs when one big atom is split into two or more smaller atoms.

Make a puzzle...using scissors, cut this picture into no more than 20 pieces.



This is an example of ____________________.

Now, exchange your puzzle pieces, with another student. Try to put the puzzle together.

This is an example of _______________.

Alternate Activity to Puzzle--Fission or Fusion?

Instead of using the cut out puzzles, the teacher may wish to have a large drawing of an atom at the front of the room. She or he could ask students to come to the front of the room and take off a part of the nucleus from the center. Explain to the class this is an example of the way fission works.

Each student could come back to the front of the class and replace their piece to the drawing. Bringing the smaller parts together is a way of demonstrating fusion. The teacher could explain it took energy for the student to leave his seat and come to the front of the room to replace the atom's part.

IX. EVALUATION SUGGESTIONS

Since each teacher may use only parts of this packet, evaluation activities are built into the lesson plans.

X. RESOURCES

RESOURCES are also listed along with the lesson plans within each unit in this packet.

XI. SUPPLEMENT

Supplemental information and materials and resources are listed on the following pages. Note: This material (except for the background information article) is labeled for use with a particular unit.

Supplement:

Background Information: For Teacher and/or Student Use.

A LETTER FROM THE DIRECTOR OF THE ENERGY ENGINEERING CENTER

Purdue University
West Lafayette, Indiana
June 30, 1978

Having now reached retirement age, this will be the last of my letters as Director of the Energy Engineering Center. To the many readers who have expressed appreciation for them, my most sincere thanks.

For this last "LETTER" I shall attempt a brief status report on the "energy crisis".

What it really boils down to is that as a nation we are gambling dangerourly with the security of our children. There are already higher prices for energy, but thus far, there has been no real energy shortage (except during the last two winters).

Oil

The problem is that we have allowed ourselves to drift into a position of strong dependency on oil from the OPEC countries. We are vulnerable to their production and pricing decisions, and, eventually, to the phasing out of their ability to continue to supply us, as well as the rest of the world, with the oil we need.

Nearly half of the energy we consumed last year came from oil, and about half of that was imported from the OPEC*. During the first part of 1978, domestic production has increased slightly, and imports are a bit less, due primarily to the approach of peak capacity through the Alaskan pipeline, and due also perhaps to wider use of lighter automobiles. This is a hopeful note, but there is little reason to believe that our OPEC dependency will decrease significantly any time soon.

Natural Gas

Our situation is complicated further by declining domestic production of natural gas, on which we rely for about a quarter of our needs, mostly for industrial and residential use. In this instance, it is not so easy to compensate for the decline in production through imports because of the complexities and expenses of having to liquefy the gas when transported from overseas. The availability of natural gas through interstate pipelines has declined about 23% since its peak in 1971 and 1972, but, another hopeful note, the decline has begun to level off during the last year, partly due to increased production from off-shore fields.

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* For 1977, total U.S. energy comsumption was about 76 quadrillion BTU's, with about 37 supplied by oil, of which nearly 19 were imported at the average rate of 8 - 9 million barrels per day.

Perhaps we will be lucky, and somehow muddle through, by finding more oil and natural gas domestically, and perhaps by the OPEC countries finding more reserves so that they can stretch out their ability to sell us what we need. But, in any case, we are already suffering from the high prices for imported oil, which must certainly exacerbate inflation and the dollar's decline abroad; and, sooner or later, we will have to be in a position to turn to other energy sources. The longer we delay, the more painful and expensive the transition will be.

The National Energy Plan, offered by President Carter in April of 1977, recognizes the importance of trying to become less dependent on oil imports, but without offering definite programs to hasten the development of new energy sources, it concerns itself almost entirely with taxing and pricing maniputlations designed to reduce oil consumption. Thus far, after 14 months, the U.S. Congress has not found these proposals to be acceptable.

Conservation

Energy conservation is not only desirable but inevitable as energy prices increase. We seem to have already made some progress in both the industrial and transportation sectors, but there is no evidence to indicate that a reasonable standard of living can be maintained without substantial increases in energy production from other sources. So far as we know today, the other possibilities include only coal, nuclear power, solar energy*, geothermal, and tidal energy. Fusion is theoretically a possibility, but its technical feasibility has not yet been demonstrated in the laboratory.

Coal

Of these energy sources, coal now supplies almost 20% of our energy need, primarily for the generation of electricity, but also for steelmaking, and for certain chemicals. With large domestic reserves, it should be the first alternate source for us to turn to with confidence. President Carter recognized this by calling for industrial switching from oil and natural gas to coal, and for an increase in coal production from its present level of about 700,000,000 tons per year to a billion tons per year by 1985. But without a specific program to ensure that this will be possible, the coal industry is confronted with an array of problems pertaining to production, health and safety, the environment, government regulations, and misinformation about the industry, to the point where there are serious doubts about now much of an increase in coal utilization can be expected, or even whether present levels can be maintained. With coal reserves calculated to last perhaps hundreds of years, depending on how fast it is mined, this should become a major source of energy, but as things stand, there are serious obstacles to moving the coal from the ground to the bottom sides of boilers where most of it is needed.

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* Solar energy possibilities include hydropower, heating, cooling, electricity generation (including perhaps micro-waving solar energy from large staellite collectors), the conversion of biomass to heat or to fuels, wind, waves, and ocean thermal gradients.

Nuclear Growth

Nuclear power has by far the largest potential as another energy source, and it is currently the fastest growing source of energy. It now supplies the energy equivalent of about one and a half million barrels of oil per day, and its fate is therefore a major determing factor regarding the possible development of a real "energy crisis". The International Energy Agency, with nineteen member nations, including the U. S., estimates that by 1985 nuclear power will be yielding energy on a world-wide basis equivalent to about 7 million barrels of oil per day*.

Nuclear technology is well developed, having been more thoroughly researched in advance than any other major industry, and having also had the benefit of extensive military experience, including the handling and storage of nuclear wastes. Nuclear plants are achieving new records for dependability and economy while continuing their exceptional safety record. For example, the 790 MW Maine Yankee plant has just broken records for light-water nuclear plants by operating steadily, without being shut-down for refueling or any other reason, for close to a year, and by generating a record of more that 6.5 billion kilowatt hours during that single operation, and all at half the cost of a comparable oil-burning plant.

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* This may be compared to the IEA estimate of total OPEC production by 1985 of about 36-38 million barrels per day in the face of a world demand for about 49 million barrels per day.

Nuclear Problems

Nuclear power is, however, also beset with problems which threaten not its present growth so much as its capacity to help avoid a future "energy crisis" and its longer-run viability. Nuclear power supplied 8% of U. S. electricity generation during 1975, 12% during 1977, and is firmly projected to supply 19% during 1985, but what happens thereafter may be a different story.

The biggest immediate problem is that very few new nuclear power plants are currently being ordered by the electric utility companies even though their executives recognize the economic benefits of nuclear plants already operating. This threatens a real "energy crisis", perhaps 10 to 15 years from now, when it seems to be a pretty safe bet that world-wide oil production will be reaching its peak, and that we will be in competition with the rest of the world for dwindling supplies. According to the Department of Energy*, there are a variety of reasons for the drop off in orders for nuclear plants. They include (1) the perception by utility executives that the Administration is ambiguous toward nuclear power and "thus might not follow through on schedule in carrying out the Federal responsibilities for licensing, spent fuel storage, waste isolation and fuel enrichment", (2) "the long and uncertain schedules, and escalating costs being incurred on plants now in construction or in the licensing process", and (3) "the difficulty in securing financing and state approvals".

The future viability of nuclear power depends finally upon breeder reactor development. Without breeders, uranium is a relatively small source of energy, to be exhausted perhaps early in the 21st century. With breeders, in which uranium may be converted to plutonium for use as a fuel, the uranium, together with thorium, constitutes an essentially unlimited resources with enough uranium having already been mined to supply our energy needs for perhaps a century.

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* "A Study of Factors Inhibiting Effective Use of Domestic Nuclear Power", Office of Energy Technology, Nuclear Power Development Division, Department of Energy, February 21, 1978.

Nuclear Policies

Our nuclear policies during the Carter Administration have been strongly influenced by concern that use of plutonium as a fuel could give impetus to the proliferation of nuclear weapons, even though it is recognized that nuclear weapons development, in the six nations which are thus far members of the "nuclear club", has never come through the nuclear power route. The "National Energy Plan" states that "Access to plutonium, or even the capacity to recover or isolate it, can lead to the risk of diversion of material that could be used for nuclear explosives devices. The United States should develop advanced nuclear technologies that minimize the risk of nuclear proliferation, but with the knowledge that no advanced nuclear technology is entirely free from proliferation risks." It became, therefore, U.S. policy to defer indefinitely the commercial reprocessing and recycling of plutonium (which means no operation of the plant built at Barnswell, S.C.) and the commercial introduction of the plutonium breeder (which means stopping work on the Clinch River Breeder Reactor Demonstration Project). Furthermore, it became U. S. policy to try to persuade other nations to do likewise. In order to try to assure that our nuclear exports are used only for peaceful purposes, Congress passed the Nuclear Non-Proliferation Act of 1978, which establishes strict export criteria on nuclear materials, including the right of the U.S. to veto both the re-export and reprocessing of nuclear fuel which we supply.

International Nuclear Developments

The foreign response, while strongly supportive of the objective of discouraging the spread of nuclear weapons, has been generally to disagree with U.S. policies as the way to go about it. For example, when the British House of Commons was faced with a decision on whether or not to proceed with the building of a new fuel reprocessing plant at Windscale, England, they voted overwhelmingly, on March 22, 1978, to go ahead even though it was clearly specified by the House of Commons leadership that this was directly contrary to the urgent recommendation of the President of the U.S. It was argued that the best way to discourage the spread of reprocessing plants among non-nuclear weapon states is to have enough of these facilities in existence to be certain of supplying all countries with the reprocessing services they need for their nuclear power program, so as not to provide incentives for such plants to proliferate.

Similarly, breeder reactor programs are moving strongly ahead in England, Russia, Germany, Belgium, Italy, the Netherlands, Japan, and France, where a full-scale plant is now being built after several years of successful experience with a demonstration breeder reactor.

There are other examples, but current developments abroad suggest that the U.S. deferral of reprocessing and breeders may lead to the viability of nuclear power finally turning out ot be greater in Europe and Japan then here. As the Atlantic Council of the United States points out in its most recent report, "With critical shortages of oil anticipated later in the century, non-proliferation objectives cannot be achieved by limiting world use of nuclear power, even were it desirable and possible"*.

Solar Energy

As to solar energy, its several applications have important potentials, from which we may certainly benefit, but in the context of out total energy requirements they will be small.

Geothermal and tidal energy should also be mentioned. Geothermal is particular may have some substantial long-tern potentials, but neither of these sources are going to reduce appreciably the energy-related risks which we are imposing on our children and perhaps our grandchildren.

Philip N. Powers
Director, Energy Engineering Center
and Professor of Nuclear Engineering
A. A. Potter Engineering Center
Purdue University
West Lafayette, Indiana 57907

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* "Nuclear Power and Nuclear Weapons Proliferation", Report of Atlantic Councils' Nuclear Fuels Policy Working Group.

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SUPPLEMENTAL MATERIALS GUIDE: ALTERNATIVES TO FOSSIL FUELS ACTIVITY

Adler, Irving
Atomic Energy
John Day Company, 1971, 47 pp

Barr, Donald
How and Why Wonder Book of Atomic Energy
Grosset & Dunlap: New York, 1961, 48 pp

Energy Reprints from ERDA
Solar Energy

Faber, Doris
Enrico Fermi: Atomic Power
Prentice Hall, 1966

Haber, Heinz
The Walt Disney Story of Our Friendthe Atom
Simon and Schuster: New York, 1956, 165 pp.

Halacy, D.S., Jr.
The Energy Trap
Four Winds Press: New York, 1975

Keifer, Irene
Underground Furnaces: The Story of Geothermal Energy
William Morrow and Company, Inc.: New Jersey

Knight, David C.
Harnessing the Sun: The Story of Solar Energy
William Morrow and Company: New York, 1976

Reuben, Gabriel H. and Joseph Di Stefano
What is An Atom?
Benefic Press, 1960

Ruchlis, Gyman
Thank you, Mr. Sun
Harvey House Publishers: New York, 1966, 45 pp.

Smith, Norman F.
Sun Power
Coward, McCann and Geoghegan, Inc: New York, 1976, 46 pp.

Wohlrabe, Raymond A.
Exploring Solar Energy
The World Publishing Company, 1966, 89 pp.

Citizens Workshop on Energy and the Environment Handbook
Contact: Dean Metz, Wayne State College, Wayne, Ne. 68787

"A Summary of Gasohol"
Pamphlet prepared by Agricultural Products Industrial Utilization Comm.
Charles R. Fricke, Administrator
Ag. Prod. IIC
301 Centennial Mall South
Lincoln, NE 68509 Phone: (402) 471-2941

Gasohol Slide Show
Contact Charles R. Fricke
see address listed above.

"Water Power-Use of a Renewable Resource"
Available from Nebraska State Energy Office
4th floor 301 Centennial Mall South
Lincoln, Ne 68509

NSTA "Factsheet"
Available from Nebraska State Energy Office
4th Floor 301 Centennial Mall South
Lincoln, Ne 68509

Supplement - Social Studies Unit

FILMS:

For Lincoln teachers, these are available from PSAB:

Number	Title	Time	Print	Grade Level
1220-14	Energy For The Future	17 mn.	c	7-12
1898-14	Energy:Can't Do Without It	14 mn.	c	4-9
1246-04	Energy From the Sun	12 mn.		7-12
1765-14	Energy Less Is More	18 mn.	c	7-12
1134-14	Energy: New Sources	20 mn.	c	4-12
1764-14	Energy: The Dilemma	20 mn.	c	7-12
1129-14	Energy: The Nuclear Alternative	20 mn.	c	4-12
1957-14	Fusion: The Ultimate Fire	14 mn.	c	7-12
1992-14	Solar Energy To Capture the Power of Sun	20 mn.	c	7-12
2018-14	There's Coal in Them There Hills	20 mn.	c	7-12

Available from UN-L Instructional Media Center:

$8.00	Energy Crisis	13 mn.	c	J - S
$18.00	Energy Crisis: The Nuclear Alternative	52 mn.	c	S - C
$6.50	When the Circiut Breaks: America's Energy Crisis	28 mn.	c	J-S-C-A

Available from the Nebraska Energy Office, P. O. Box 95085,
Lincoln, NE 68509 (402) 471-2867

When the Circuit Breaks	25 mn.
Saving Home Energy	22 mn.

ITV: Future Studies series...30 min. lessons; Senior high.

Wednesday, November 22, 1978, 8:00 p.m.

Organic Farming: Can It Feed the Multitudes?

January 31, 1979, 8:00 p.m.

Energy: Towards the Age of Abundance

February 7, 1979, 8:00 p.m.

Fusion: The Electric and Infinite Future

April 18, 1979, 8:00 p.m.

Waste: Recycling the World

BOOKS:

The Energy Challenge - free; activities with dittos.

Write to: The Energy Challenge
P. O. Box 14306
Dayton, Ohio 45414

The Dragons of Eden by Carl Sagan; Random House, New York; 1977, timeline.

SUPPLEMENTAL SOLAR ACTIVITIES FOR THE SCIENCE UNIT

Obtain a colored bottle and a clear one which has the same capacity. Place about 25ml of water in each. Place identical balloons over the mouth of each bottle and set both in the sun. Observe the results.

Paint one can black and an identical one white. Put water in each and place them in the sun. Which can heats up faster? Freeze water in both cans and watch the melting rate when both are placed in the sun.

Place a black and white square of paper on the snow in the sun. Observe the results.

Place water in a clear closed container and put it in the sun. Make tea, etc. out of the hot water.

Paint several identical cans black. Put various materials such as sand, salt, flour, water, paper, vegetable oil, etc. in them and place them in the sun. Observe the relative heating rates of the substances. Observe how long the various materials retain their heat.

The aspects of the focussing of the sun's rays can be investigated with shiny curved surfaces or magnifying glasses. Hot dog cookers, water heaters and paper burners can be made and tested using these concepts.

Paint two different sized pie plates black. Place the plates in the sun with identical amounts of water for identical time intervals. Quickly pour the water from each into two styrofoam cups and measure the temperature. Try to heat the water in the small plate to the same temperature as before with a candle. How long does it take and how much does the candle burn? Place two identical black plates with water in the sun and the shade and observe the differences.

Cut a large hole in one cardboard box and cover it with plastic wrap and tape to serve as a window. Leave an identical box intact. Place both in the sun to observe the effect of the window. Check the effects when the window is pointed away from the sun.

Boxes can be used to construct model houses with different roof shapes, materials and colors. Experiments can also be designed which vary window patterns, house orientation to the sun or insulation materials and thicknesses.

Boxes, styroforam coolers and other containers can be converted into simple solar cooking devices simply by varying the arrangement of plastic covering material, shiny reflecting material and black covered surfaces. Have the students experiment with these arrangements to make cookies out of refrigerator cookie dough.

This is a listing of solar facilities in Nebraska. If there is a facility near your school, we recommend a field trip. Contact the person listed in this guide nearest your school to arrange a tour.

SOLAR ENERGY SYSTEMS
Directory for Nebraska

by Midwest Energy Alternatives
2444 B Street, Lincoln, NE 68502
Phone 477-3101

ALMA
Tom McNally (owner) 308/928-2834
Solar-aire (mfg. by Solar-Aire Inc., Mead)

AINSWORTH
Richard Schipporite (owner)
Box 134
Built solar house passive system with wood heat back-up

ALEXANDRIA
Mr.& Mrs. Richard Dill (owners - builders)
Solar heated home over 40 years old

ASHLAND
John McLaughlin (owner - Pres. of Solar Inc.)
Woodland Hills (section)
Solar heat

Kingdom Hall-Jehovah Witnesses
18th & Valid
Solar heated church by Solar Inc.

Bill Farmer (owner) 944-7458
602 Dale Street, 68003
Solar house - a retrofit on older home
Charles Thomsen, Architect

ATKINSON
R. B. Schmaderer (owner) 925-2626
4th & Holt Streets
Solar heating system for heating home with hot air

AURORA
Harry Eckerson (owner)
805 N
Solar Bee-wax extractor

Ros R . Black, Sr. (owner) 694-3423
1703 "A" Street
Solar project to produce electricity from wind

BARTLEY
Bartley Lumber Co.
Solar Space heating system (air)

BEATRICE
Robert J. Landen (owner - builder)
908 - 910 West Mary 228-2015
Solar Space heating system (air)

BELDEN
Earl Fish (owner) 985-2270
Solar grain dryer

BELLEVUE
John Lippincott (owner) 292-6718
2213 Twin Ridge Drive
Heating system for a home

Dean Lightfoot 291-3888
Bellevue Plaza, 1811 Hillcrest Drive
Hot line concentrating solar collector

BLUE SPRINGS
Robert J. Feit (owner - builder)
RFD No. 1 645-3835
Underground house, energy conserving designs

BENNET
Vern & Ruby Plages (owners)
162 & Saltillo Road
Energy efficiency home, passive solar heating

BRAINARD
Municipal swimming pool (owners - Village Board)
Solar heater

BRULE
(owner ?)
T. & B. Energy Co.
Solar heat "A" frame unit

CALLAWAY
Callaway Housing Corp.
Solar heating, space and hot water
To construct 8 apartments under a HUD Grant
$31,700

CEDAR BLUFFS
Robert Beake (owner)
Building solar retrofit

CHADRON
Jerry Bell (owner)
Solar heated "A" frame unit

CHAPPELL
Gary Brun (owner) 308/874-2509
Route 2
Solar heated "A" frame unit
Champion Energy King

COLUMBUS
Warren Rushton (owner) 564-1646
Route 3, Discovery Subdivision
Solar heated forced air heating with partial underground construction

Mark Johnson (owner)
3104 8th Street
"A" frame, rock storage unit, Model 128
Metamore Homes (builder)

Buster Johanson (owner) 564-4991
3414 34th Street
Solar assisted heat pump

COZAD
Howell Lumber Co. (owner) 308/784-2421
Roger Schmitt, Manager Solar-Aire (mfg. by Solar Inc.)
Only collectors will be used for daytime space heating of the office/display area

CRAB ORCHARD
John Menninga (owner) 876-5411
Solar heated for house heating with hot air and water heating

CURTIS
Tom Reinus
Solar heated "A" frame unit

DAVEY
Jerry & Sher Jaksha (owners - builders, Solar System)
Vertical air transfer system with rock storage (under construction)

DECATUR
Dr. Kenneth Lange McGill (owner)
RR 1, Box 53 (on highway 73 about 5 miles south)
Wind generated electricity for home use

DENTON
Lyle Shearer (owner - builder)
SW 99th W. Saltillo Road 797-3195
Subterranean house, energy efficient, using earth insulation on three sides and roof

DILLER
Jerry Munsterman 793-5365
Solar heat, air; Sun-trac system "A" type from Future Systems, Inc., Electric Service in his business place (dealer)

EAGLE
Lunar Bar & Grill (owners)
Solar heated "A" frame from Sun Co.

ELKHORN
(owner ?)
Solar Inc. System

Paul Decker 289-2121
21160 Shiloh Circle
Energy efficient house with solar hot water heater

FAIRBURY
(owner ?)
Solar Inc. System

FT. CALHOUN
Charles H. Morton, Architect
Solar house under construction

FAIRMONT
John Krejci (owner) 268-2644
2½ miles south on highway 81
Solar heated hog house (under construction); winner of the Solar Search Contest

FREMONT
Ray Buckridge 721-9378
Buckridge Homes, Inc. P.O. Drawer M
1835 E. 1st Street
Solar heated "A" frame unit (installed)

Marloe D. Ellingson (owner)
1009 Jones Drive
Energy King in the back yard

(owner ?)
N. W. corner of housing project
Solar Inc.

FORDYCE
Linus Lange (owner) 357-2226
Solar water dairy heater

GENEVA
Dick Nichols (owner)
Solar house, heat pump system, eutectic salts storage

GRAND ISLAND
Howard Bonsall (owner)
Bonsall Co.
Solar heated "A" frame

Tri-City Beer, John Folsom (owner)
East 4th Street
Solar heated "A" frame from Sun Co.

Dave Lentz (owner)
334 Pheasant Drive
Solar heated "A" frame from Sun Co.

Richard Schwartz (owner)
RR No. 3
Solar heated "A" frame from Sun Co.

Alfred Zimbelman (owner)
1612 N. Locust Street
Solar heated "A" frame from Sun Co.

Calvary Apostolic Church
515 South Oak
Builders: Henry Showolter, 1508 W 308/384-9165
John and Paul Bonnev, 308/384-1356
Home built air and water collectors using OTTO Fabric "TC" glazing for daytime heating and MITOMIT water collectors

GRETNA
John Schell (owner - builder)
Solar air heater; beer can collector

HALSEY
State Park
Solar water heating system built according to Domestic Tech. Inst. plans at a solar workshop

HARTINGTON
Rick Pinkelman (owner) 254-6641
Solar farrowing barn; small farm energy project

Dennis Engel (owner)
Engle Lumber Co.
Solar heated "A" frame from Solar King

Dr. Earl Dean (owner) 462-9619
606 No. Main
Retrofit on existing residence from Solar-Aire (mfg. by Solar, Inc., Mead)

HOLDREDGE
Jim Brown (owner) 995-8047
1205 Lincoln Street
Solar heated "A" frame from Energy King

J. H. Jones (owner)
RR No. 1
Solar heated "A" frame unit from Sun Co.

JENSEN
(owner ?)
Solar Inc. System

KEARNEY
Dwane Nickle (owner) 234-9521
Rural Route
Office building with Solar-Aire (mfg. by Solar, Inc., Mead)

Steve Hochreiter (builder) 236-5534
2903 Kimler Ave.
Heating for home

LEXINGTON
Dale Hanna 308/324-2783
RR 2
Solar heated "A" frame

LINCOLN
Virgil Anthony (owner)
1315 Nelson
Built an experimental solar heater on his garage out of scrap metals

Brunswick Corporation Building
4300 Industrial Ave. 464-8211
Solar panels testing located on top the building
Gary Jageman - Designer, 5850 Elkcrest Drive 483-1060

Dr. Eli Chesen (owner) 432-7557
3531 Cooper Ave.
Swimming pool heater which heats the pool using solar energy without the use of solar collecting panels

Richard P. Day (owner) 423-4080
Rokeby (1 mile south and 1 mile west)
SW 27th and Saltillo Road
Solar heat, heat pump
No visitors please

Roy Decker (owner) 467-3335
5512 Cloudburst Lane
Hydronic solar system with heat pump

George & Loretta Fisher (owners)
3620 Briarwood Ave.
Solar home: "A" type system installed by Don House (Valparaiso), Leon Swails with Jinel Construction (builder)

Forest Furnace & Air Conditioning Co.
651 Peach Street
Solar heated "A" frame from Sun Co.

Dr. Richard W. Hammer (owner)
5000 N. 7th Street 432-2070
Solar heated swimming pool, built by Mark Hammer (age 16)

Hub Hall (owner) 483-2551
7131 Willow
Solar home under construction, system by Solar Inc.

Hyde Memorial Observatory
Holmes Lake Park
Solar heated

Carl (Bud) Irons
6300 Cornell
Solar heated "A" frame from Sun Co.

Ben Lehnus (owner) 489-1517
2645 So. 53rd Street
Solar air collector built by MEA and LAP

Prof. Ted Jorgensen, Jr. (ret. Physics, UNL) 435-5737
3455 "L" Street
Energy efficient home

Lincoln Electric System
UNL house, north of Rokeby
Solar and heat pump
(contact LES for tours)

MEA Office L. B. Justice (owner - builder) 477-3101
2444 "B" Street
Solar heated; beer can collector with brick storage; retrofit

Peterson Construction Co. (owner)
1325 Galloway & S. 14th Streets
423-7701
Hydronic solar space heating system; Miromit Solar Collector (built in Israel)

Egan Reisel (owner - builder)
2401 West A Street 435-1313
Solar space and water heat

Jacob Schaffer (owner) 464-2382
840 No. 59th Street
Solar heated "A" frame unit; self-contained unit with rock storage in back yard by American Energy Savers (D. Lentz)

Charles L. Thomsen (owner) 464-5496
1141 Carlos Drive
Solar retrofit; air type collector on roof

Women's P. E. Building
UNL Mabel Lee Hall
Solar heating system for domestic hot water, monitored by UNL

LOUISVILLE
John Bojanski (owner) 234-5405
Bojanski Trailer Court
Solar-powered heating unit using 10,000 aluminum cans

LYMAN
Mark Morrison
Has shop or factory to build Chalk design wind generator turbines

MARTELL
Owen Heusenkvelt (owner) 787-3207
RFD
A wind generator is under construction

Dave Carter (owner)
RFD (1½ miles south of town)
Solar heated earth insulated home

MCCOOK
LeRoy Ulrich (owner) 345-2484
612 W. 4th Street
Solar heated "A" frame unit

MEAD
John McLaughlin 624-6555
Solar Inc. - Manufacturing solar systems
Solar heat, solar heated office building, eutectic salt storage

Mead Experimental Station
UNL and MIT
7 miles east on highway 63, north 2½ miles, east ½ mile
Solar powered irrigation, photoelectric cells

MILFORD
Gene Waring (owner)
812 2st Street
Do-it-yourself solar heating system

NIOBRARA
Kent Schweers (owner)
Box 82
Octagon house heated by solar panels and solar greenhouse cooled by air from eight yard rock storage

NORFOLK

Schwinn Bike Shop, George Andrews (owner)
Solar heated

Donald Klinetobe (owner)
Route 1 NE of city, on road from Highway 35 to the steel plant
Solar panels and a wood furnace

Larry Griffith (owner)
2307 Clearfield Drive
Solar heated "A" frame unit, Champion Home Builder dealer for solar unit

Dan & Vondel Geary (owners - builder)
2003 W. Benjamin Ave.
Solar heat and cooling built by Geary Electric Inc., air and water copper collectors on roof

Earl Shipley (owner)
115 Sycamore Ave.
Do-it-yourself solar system, retrofit

Orivlle Voss (owner)
721 East Park Ave.
Do-it-yourself solar heat space; air; aluminum can collector and wood furnace

Wayne Walters (owner)
500 North Boxelder Street
Solar heated by Solar Inc. Mead

NORTH PLATTE

Clarence Bell (owner)
Lake Maloney, Lot 226
Solar-Aire (Solar, Inc., Mead), under construction

Everett Welty (owner)
3014 W. 2nd Street
Solar greenhouse heating

Ken Dragoo 532-6507 (home) or 532-5507 (business)
820 West Phillip
Solar heated "A" frame by Solar Utilities

OMAHA

Elizabeth Brougham (owner)
7453 Schuyler 391-8320
Space heating

Tom Colgan (owner)
12679 "C" Street
Flat-plate air medium solar collectors mounted vertically on the wall at 3206 So. 127th Street

Carl Keller (owner) 333-1265
EnerJ-tex 556-0550
11653 Douglas
Solar systems hydronic unit

Jim Putman (owner - President of Thornton Construction)
15117 Westehestern Circle
Solar Inc. of Mead system

Ted Perry (owner) 342-2040
2531 Davenport
Solar house at 12735 "C" Street under construction
Flat-plate air collector; "A" type; Champion Home Builder
No visitors, please

Ted Perry (owner) 342-2040
2531 Davenport
Solar house at 6939 "L" Street under construction
System will heat a model home which has no furnace; Champion Home Builder (mfg.); "A" frame

John & Bev Traudt (owner)
3316 Agusta
Wind, electric, 6V, 200 watts; installed by Natural Power Systems (same address as above)

Energy King, Solar Heating, Inc.
4430 So. 108th Street 331-3880
Solar model home ("A" frame)
18109 Sunset Lane
Wood burning fireplaces

Ken Long, Engineering and Allan Fries, Builder
26 So. 140th Street
Solar heated and air conditioned house by Solar Air Co.

OGALLALA

T. & G. Energy Company
Three homes with solar heated systems

PANAMA

Lee Schrierer (owner) 788-2519
Solar house near town under construction

PLATTSMOUTH

Gary Benedict Builder
1200 Queens Way
Solar heat; space and water heater; Quadro Inc. solar heating project in multi-family dwelling

PLEASANT DALE

Cliff Irwin (owner) 795-2375
"A" type solar heater by American Energy Savers

PLYMOUTH
Gerald Shepard (owner)
Shepard Construction Company
RR 1
Solar heated "A" frame from Sun Co.

POTTER
Ervin Bauer (owner)
RR. 1, Box 40
6' vertical axis "Air Wheel" - is to be used to drive an alternator that will provide power for an electric base-board heater in the home

RED CLOUD
Robert Beardslee (owner) 746-3442
38 No. Seward
Greenhouse collector storage ventilation

ROCA
Jim Rakers (owner - builder)
RFD (So. 27th Street
Solar swimming pool heater; wants to build underground house

ST. HELENA
Benny Kaiswe (owner)
RFD
Wind, electric, 200 V., 4,000 watts, for farm and home use; installed by Natural Power System, Inc. 3316 Augusta Ave., Omaha, NE

ST. LIBORY
Erick Kuck (owner)
Solar heated "A" frame unit

SHELTON
Glenn Heuring (owner)
RR 2, Box 126 A
Solar heated "A" frame unit by Champion Home Builder

SHICKLEY
Gerald Stengel (owner) 627-3156
West and north of town
Solar-Aire (mfg. by Solar Inc.)

SEWARD
Kingdom Hall - Jehovah Witnesses
Solar heated church

Cattle National Bank Building (owner)
Installing a hydronic solar system that provides heating and air conditioning designed by Long & Noel Associaties of Lincoln, NE

SYRACUSE
Dr. & Mrs. C. E. Moss (owners)
Wind, electric, 200 V, 200 watts for home use; installed by Natural Power Systems, Inc., Omaha, NE

Solar Inc. System; located somewhere in town, not sure where

TABLE ROCK
Edward Slider (owner)
Solar project design to create heating for home use

UNION
Larry Krell (owner)
Solar greenhouse; windmill under construction

VALLEY
There is a Solar Inc. system, not sure where

VALPARAISO
Donald House, (owner)
Rt. 1, Box 140 A
Solar heated "A" frame unit; Solar House Co., Energy King Solar Furnace and handles Boyd Wood heating system

WAHOO
Liquor Store
Highway 71 and 92
Solar Inc. system

Vennie Kavan (owner - builder)
Rt. 1
Solar heated hog house; passive and active system by Ag. Eng. Dept. of UNL; call Jim DeShazer for information, 472-2824

WYMORE
A Solar Inc., system, not sure where

WAYNE
Bob Carhart (owner)
Carhart Lumber
Solar furnace "A" type dealer

WYNOT
Edgar Wuebben (owner)
Solar water heater and fruit dryer; window box collector; manure composting

VALENTINE
Joan & David Mathison (owners)
Box 644 376-1339
Earth insulated energy efficient home

YORK
Champion Solar Heating Furnace
Mfg. by Metamora Homes Doug George, quality control systems; Bob Jacobsen, manager

Chris Buller (owner)
224 So. 40th Street, Lincoln, NE
House, 614 East Ave.
Solar heating system for home

(Late Additions)

FAIRMOUNT
Danna Galusha
Testing green us black collector
plates (school solar project)

LINDSAY
General Alfred Kalberer (owner)
RFD 291-1288
Hot-line Solar system concentrator collector

LIBERTY
Roger Sejkora (owner - builder)
Solar heating system 696-4335

ENERGY: YESTERDAY, TODAY AND TOMORROW

Unit #3

LIVING WITH ENERGY - SOCIAL STUDIES ENERGY ACTIVITIES

by

Susan Pierce
Nikki J. Scott
Dianne J. Kennedy
Richard W. Lourien
Patty Kondo
Geri J. Irel

Prepared for
the Nebraska Energy Office

Attitudes - Yours and Others

Materials needed:

Energy Inventory (taken by each student as part of the General Overview Pretest)

Suggested Activities:

A. Class Discussion

From the results of the attitude survey (energy inventory) select certain questions from it on which students have varied opinions. To generate a class discussion, ask students why they agree or disagree with the statements.

An alternative would be to divide the class into two sections and have a debate between them concerning selected questions from the energy inventory. Each side should try to convince the other side to see the issue their way.

This could be preceded by a brief discussion on what influences our attitudes. A list could be written on the blackboard or overhead.

B. Group Discussion

Divide the class into small groups (3 - 5 each). Give each group one of the following statements to discuss.

1. Bigger is better
2. Less is more
3. Small is beautiful

Tell the groups that they are to decide: 1) how the statement relates to energy; and 2) if they agree with the statement. Ask each group to tell the class as a whole what they decided.

C. Individual Activity

Each student will select five questions from the energy inventory and do the following:

1. ask five people their own age and five adults to answer those questions; and
2. hand in the results and a written reaction to the results.

If desired, the teacher could ask a few students to report some of their results to the class to generate discussion.

Energy History

Materials needed: 3 Thermofox transparancies
overhead projector

Activity: Display the "Cosmic Calendar", beginning with the cosmic year, then the month of December, and conclude with December 31. On the final transparancy, the instructor may cite landmark events to place the times in perspective.

This should stimulate discussion of the brief time humans have been on earth, and the more brief time span of energy useage.

The instructor may point out that fossil fuels as a source of energy will last only about a second in cosmic time.

PRE-DECEMBER DATES

BIG BANG CORIGIN OF THE UNIVERSE	JANUARY 1
ORIGIN OF THE MILKY WAY GALAXY	MAY 1
ORIGIN OF THE SOLAR SYSTEM (sun)	SEPTEMBER 9
FORMATION OF THE EARTH	SEPTEMBER 14
ORIGIN OF LIFE ON EARTH	SEPTEMBER 25 (approximate)
FORMATION OF THE OLDEST ROCKS KNOWN ON EARTH	OCTOBER 2
DATE OF OLDEST FOSSILS (Bacteria and Blue-green algae)	OCTOBER 9
INVENTION OF SEX (by microorganisms)	NOVEMBER 1
OLDEST FOSSIL PHOTOSYNTHETIC PLANTS	NOVEMBER 12
EU KAROYTE (First cells with nuclei) FLOURISH	NOVEMBER 15

COSMIC CALENDAR: DECEMBER

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1 Oxygen atmosphere begins to develop	2	3	4	5 Volcanoes active	7
7	8	9	10	11	12	13
14	15	16 First worms	17 Invertebrates flourish	18 First plankton in the ocean	19 First fish, first vertebrates	20 Plants begin colonization of land
21 First insects, land animals begin	22 First amphibians, first winged insects	23 First trees and reptiles	24 First Dinasauers	25	26 First mammals	27 First birds
28 First flowers; dinasauers become extinct	29 First primates	30 Giant mammals flourish	31 First Humans			

V-4-C

DECEMBER 31

1:30 p.m.	Ancestors of apes and men
10:30 p.m.	First humans
11:00 p.m.	Widespread use of stone tools
11:46 p.m.	Domestication of fire by Peking man
11:56 p.m.	Beginning of most recent glacial period
11:58 p.m.	Seafarers settle Australia
11:59 p.m.	Extensive cave painting in Europe
11:59:20 p.m.	Invention of agriculture
11:59:35 p.m.	Neolithic civilization, first cities
11:59:50 p.m.	First dynasties in Sumer, Elba, and Egypt; development of astronomy
11:59:51 p.m.	Invention of alphabet
11:59:52 p.m.	Middle Kingdom in Egypt
11:59:53 p.m.	Invention of the compass, bronze age
11:59:54 p.m.	Iron age, founding of Carthage by Phoenicia
11:59:55 p.m.	Periclean Athens
11:59:56 p.m.	Roman Empire, birth of Christ
11:59:57 p.m.	Rome falls
11:59:58 p.m.	Crusades
11:59:59 p.m.	America discovered, experimental science developed
NOW: The first second of New Years Day	Widespread science and technology, global culture, space exploration

Historical Energy Sources

Materials needed: Transparancy copier,
Overhead projector,
Individual copies of
"Diary of a Colonial Farmer"

Suggested Activities:

A. Use the pictorial page on the overhead projector as an introduction. Students may respond orally to the four questions to provide psychological set.

B. Have each student read "Energy and Cultural Patterns: the Colonial Farm".

Student Hand-Out 3

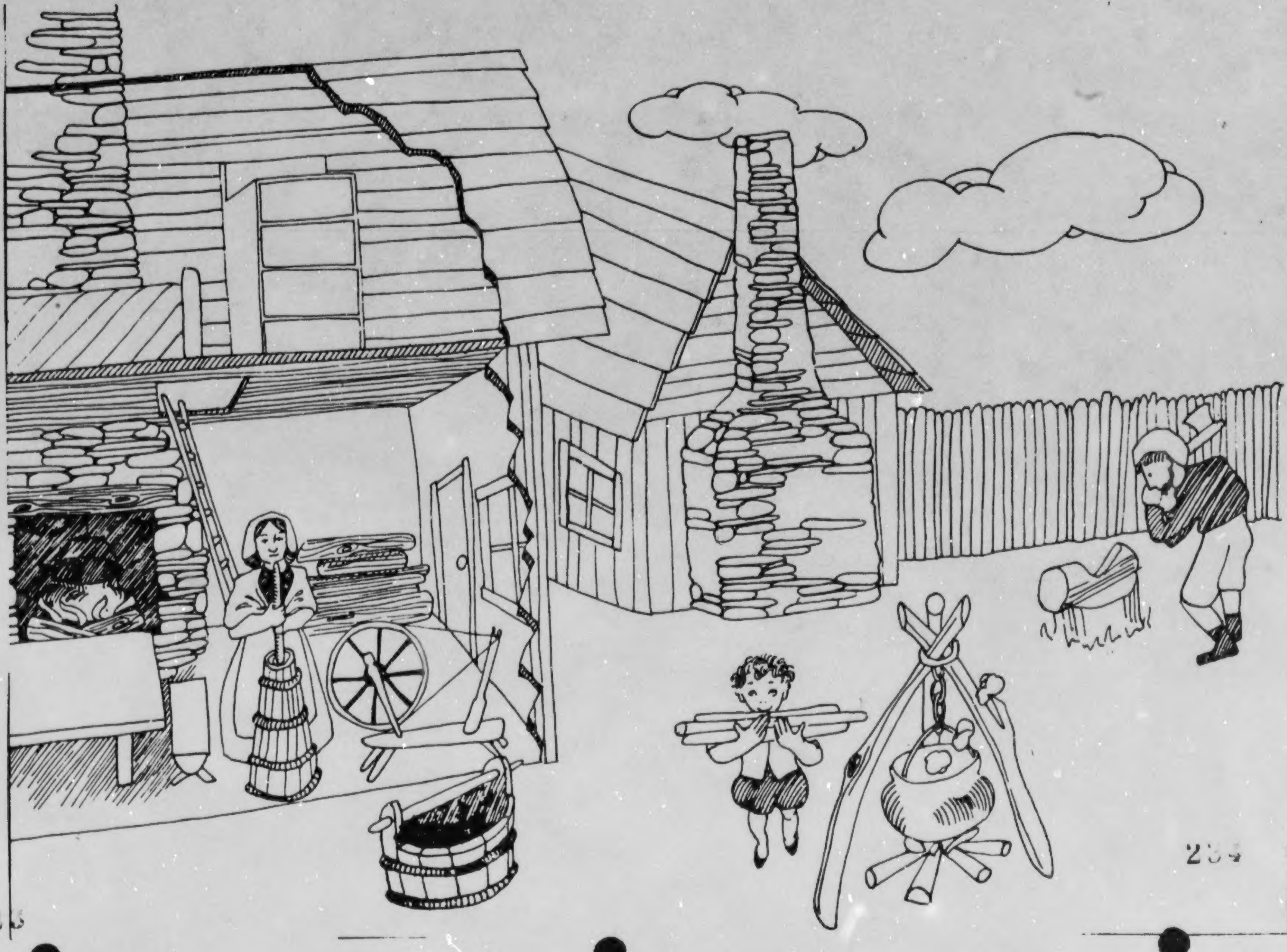
1. What are the uses of wood in the picture?

2. What are examples of energy being used in the picture?

3. What examples show that human muscle power was used to produce the necessities of life?

4. Why were wood and human energy used more in the colonial period than today?

V-8-C



Activity 4

Energy and Cultural Patterns: The Colonial Farm

Using the information from the diary, the picture of the farm family and the previous readings, complete the following chart.

1. What sources of energy were available to the settlers?

2. Show how the following tasks were done by the settlers. What energy was used in these tasks?

    a. Producing food

    b. Preparing food

    c. Building homes and barns

    d. Lighting and heating homes

    e. Preparing clothing

    f. Making furniture

3. List two jobs performed by each member of the family.

    a. Mother

    b. Father

    c. Children

4. In the colonial period, what made one family wealthier or better off than another?

Student Hand-Out 4

Read the selection below. Then fill in the chart using the information from the Diary.

Diary of a Colonial Farmer

5:00 am	Got up and fed the oxen, pigs and chickens. Wife started fire and cooked breakfast. A cold morning. Frost everywhere. Milked the cow.
6:00 am	Ate pork and buttered cornbread for breakfast. Have to make another chair so our youngest child will have a place to sit. Maybe I can do it tomorrow.
7:00 am	Hitched up the oxen to the plow. Started to plow half our field. Will have to get ready to plant wheat and corn. Hope to plow the other half next week.
11:00 am	Weather finally warmed up some. Wife and children spent the morning hoeing in the garden. Soon the time will come to plant onions, melons... Finally finished plowing. Took oxen back to the barn.
12:00 pm	Finally had lunch. Still thinking about making that needed chair. Had fruit, salted pork, and cornbread for lunch.
12:30 pm	Went to work in the orchard. Hope the blackbirds don't eat too much of the fruit. Have to cut off all the dead limbs on the fruit trees. Only worked on some of the trees. After cleaning up the lunch dishes, wife spent the afternoon spinning thread. We all need some new clothes for summer. I'm thinking about trading a pig for new shoes for the family. Haven't got time to make shoes. Children finally got to go fishing.

Diary of a Colonial Farmer
(continued)

4:30 pm Too tired to trim any more fruit trees. Had hoped to remove some tree stumps from the field. Maybe I can get to that before too long. Neighbor Thomas will help. Last week I helped him pull up stumps. Wife began to prepare supper. I'm glad children caught fish. We'll have them for supper with some boiled cabbage.

5:00 pm All of us had supper. Still thinking about making that chair. Wife and children got supper dishes cleaned up. Children brought in some firewood. I milked the cow and fed the livestock again.

7:00 pm Started to get cold again. Said evening prayers and children went to bed. I repaired a broken plow and wife patched some clothes. Reminded myself to get wood for that chair I must make.

8:30 pm Wanted to clean my rifle first, but instead used the remaining light from the fire to write in my diary and read the bible.

9:15 pm So tired. Went to bed.

"The Life of the Farmer", The Americans, Edwin Fenton, Editor, Holt, Rinehart and Winston, New York, 1975, pp. 45-46.

THE GOOD OLD DAYS?

Materials: You may want to put this on a ditto.

Directions: The student will interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. The results should be handed in and may be discussed as a class if desired.

Questions:

1. What kind of lights did you use in your home as a child? How was it heated?
2. What fabrics were clothes made of? Was clothing harder or easier to take care of?
3. What kind of washing machine did you have?
4. What kind of stove (and what kind of fuel) did your family use for cooking?
5. Did you have a refrigerator? What other appliances did your family have?
6. How was your water heated for bathing and laundry?
7. Did your family have a car? If not, how did you travel? How did you get to school?
8. Did you have a radio? What did it look like? What kinds of entertainment did you enjoy?

10. In what ways is life for you more enjoyable now that we have electricity,plastic, detergents, and other oil and natural gas products?
11. In what ways did you like the "good old days"

CHANGING LIFESTYLES

Materials Needed:

Handout: "A Day Without Energy" for each student.

Suggested Activities:

A. Have each student complete the handout and follow with a brief discussion of their ideas; or,

B. Have the class as a whole determine what a day without energy would be like. All class members could participate, with the teacher writing the agreed upon ideas on the blackboard or overhead.

A DAY WITHOUT ENERGY

Name: ______________________

Date: ______________________

All the energy is gone!!! What will you do today????

7:00 - 8:00 a.m.

8:01 - 9:00 a.m.

9:01 - 10:00 a.m.

10:01 - 11:00 a.m.

11:01 - 12:00

12:01 - 1:00 p.m.

1:01 - 2:00 p.m.

2:01 - 3:00 p.m.

3:01 - 4:00 p.m.

4:01 - 5:00 p.m.

5:01 - 6:00 p.m.

6:01 - 7:00 p.m.

7:00 - 8:00 p.m.

8:01 - 9:00 p.m.

9:01 - 10:00 p.m.

YOUR ENERGY VALUES

Materials Needed: One copy of "Your Energy Values" handout for each student.

Suggested Activities:

Have students individually rank the items.
Determine which item was ranked #1 most often, and which was ranked #14 the most.
Choose a few items to generate a class discussion.

YOUR ENERGY VALUES

Name: ____________________

Period: ____________________

The President of the United States has just made an announcement on national television. He has commanded every man, woman, and child in the United States to decrease their energy intake by 50 percent immediately. The United States is faced with a terrible energy shortage, and everyone must cut their energy use in half.

Your survival depends on this. Your task is to rank the 14 items in terms of their importance. Place the number "1" by the item which you would agree to first. Place the number "2" by the second item and so on. You must rank all of the items.

_____ Outlaw all driving on Sunday

_____ Set speed limits at 50 miles per hour

_____ Give up all Christmas lighting, indoor and outdoor

_____ Set thermostats at 64 degrees in homes

_____ Ban all visits to relatives and friends over Christmas vacation if more than 25 miles away.

_____ Limit television to a period from 8:00 a.m. to 6:00 p.m.

_____ Pay $1.00 a gallon for gasoline

_____ Shut down schools for 1 winter month: make-up time during the summer.

_____ Limit family to five gallons of gasoline per week

_____ Ban the use of any electricity after 8:00 p.m. except in hospitals

_____ Cut police and fire protection in half

_____ Cut down on bus transportation: buses only run during the hours of 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.

_____ Outlaw use of washers and dryers, dishwashers, garbage disposals, hair dryers, radios, television, stereo, and other such items.

_____ Turn off all street and yard lights.

ENERGY CONSUMPTION

Materials needed:

Handout for each student:

1. "Electrical Consumption for Some Common Home Appliances"
2. "Energy Consumption by Home Appliances and Lighting"

Suggested Activities:

A. Using handout #1, have each student determine how much energy their family consumes each year. They may need to complete this at home.

Ask students:

What appliances use the most energy? Are they necessities or luxuries? Are they for comfort or survival?

If energy consumption was cut, which appliances would probably be first to go?

B. Using handout #2, have each student select the appliances they would use for a year with a $100.00 limitation. Afterwards, this can be compared and discussed with the class.

ELECTRICAL CONSUMPTION FOR SOME COMMON HOME APPLIANCES

APPLIANCE	ANNUAL KWH CONSUMTPION
Blanket	147
Broiler	100
Carving Knife	8
Clock	17
Clothes Dryer	993
Coffee Maker	106
Dehumidifier	377
Drill	65
Dishwasher	363
Fan attic	291
Furnace	450
Fan, window	170
Food blender	15
Food freezer	1,195
Food freezer, frostless	1,761
Food mixer	13
Food Waste Disposer	30
Frying Pan	186
Grill	33
Hair Dryer	13
Heat Lamp	13
Heater Radiant	176
Heating pad	10
Iron	144
Light bulbs	25
Radio	86
Range	1,175
Refrigerator	728
Refrigerator, frostless	1,217
Refrigerator, freezer	1,828
Sewing machine	205
Shavor	18
Television (B & W)	362
Television (Color)	502
Toaster	39
Tooth Brush	5
Vacuum Cleaner	46
Waffle Iron	22
Washing Machine, automatic	103
Washing Machine, non-automatic	76
Water heater	4,216

ENERGY CONSUMPTION BY HOME APPLIANCES & LIGHTING

	Pounds of Coal	Annual Energy consumption (KWH)	Gallons of Oil	Annual Cost of energy consumed*
Air Conditioner	321	2000	54	$47.20
Electric Blanket		150		3.54
Can Opener		0.3		.01
Clock		17		.40
Clothes Dryer	312	1200	32	28.32
Coffee Maker		100		2.36
Dishwasher (heated)		350		8.26
Fan (attic)		270		6.37
Fan (furnace)		480		11.33
Fluorescent Light (3 fix)		200		6.14
Food freezer (16cu ft)	312	1200	32	28.32
Food Mixer		10		.24
Food Waste Disposer		30		.71
Frying Pan		240		5.66
Hair Dryer		15		.35
Hot Plate (2 burner)		100		2.36
Iron (hand)		130		3.54
Light Bulb	417	1870	51	44.13
Radio (solid State)		20		.47
Radio Phonograph (solid State)		40		.94
Range	403	1550	42	36.58
Refrigerator (12cu ft) (frost free)	195	750	20	17.70
Sewing machine		10		.24
Shaver		0.6		.01
Television (B&W)		400		9.44
Television (Color)	140	540	15	12.74
Toaster		40		.94
Vacuum Cleaner		45		1.06
Washer (automatic)		100		2.36
Stereo		400		9.44
TOTALS		11,938 KWH		$281.72

* Cost of Electricity = 2.33 cents per kilowatt hour.

ENERGY CONSERVATION

Materials Needed:

"104 Ways to Control Your Electric Bill". Make a ditto handout for each separate section rather than give each student the entire handout.

Suggested Activities:

Divide the class into groups of 2 - 3 students. Assign each group a section of the handout. Each group will design and make a poster suggesting 2-3 ideas for conserving energy. When completed, each group will explain their poster to the class. The posters should then be displayed in the room.

104 WAYS TO CONTROL YOUR ELECTRIC BILL

INTRODUCTION

The knowledge that the nation's energy is not drawn from a bottomless source came as a sobering jolt for most Americans. After the first rush of panic, however, all of us found that the dark cloud had a silver lining--that there was some good news along with the bad. The good news was that we really wouldn't have to do without energy...we merely would have to use it wisely.

Conservation is of itself a good thing, a common sense habit that should be adopted for dealing with all of the earth's natural resources, scarce or bountiful. In the case of fossil fuels and electricity, common sense is joined by necessity as motives for conservation. Wise use is absolutely essential if we are to gain the time needed for America's enormous research and development capability to work out alternate energy sources.

Residential applications of electricity offers great opportunities for using energy wisely. The purpose of this booklet is to share these opportunities with you in the major areas of home heating and cooling, lighting, cooking, water heating, laundering and refrigeration.

Though some of the tips may be familiar, many are new. So read the booklet carefully and profit from it fully.

HEATING

The most important single step in residential energy conservation is the installation of thermal insulation, which should be specified in terms of thermal resistance (R-values). Minimum value of R-11 (3 inches) is recommended for exterior walls, R-19 (6 inches) for ceilings under roof or unheated spaces; R-11 (3 inches) for floors over unheated areas. These are mimimun values. In cooler areas of the country, additional insulation above these values should be considered.

Double glazing (two panes of glass seperated by a sealed air space) cuts heat transfer by 40 to 50 percent. In extremely cold regions, triple glazing could be economically justified.

Single-glazed windows (even those of high quality and in good repair) should have storm windows. A wood or metal frame storm window provides a second thickness of glass and a layer of still air that retards heat transmission markedly.

Install storm doors at all entrances to the house. A storm door helps save energy because it reduces the mass of air infiltration that occurs when the prime door is opened and, also, reduces the amount of heat transfer through the prime door when it is closed.

Increasing glass area increases heat losses and gains. In choosing window sizes for a new home, therefore, carefully balance the needs of the occupants for light and view with the need for energy conservation.

Replace broken window glass, worn weather stripping and improperly fitting doors.

Weather-strip and caulk around all entrances, doors and windows to limit air infiltration which could account for 15 to 30 percent of space conditioning energy requirements.

Encourage occupants--children especially--to keep windows and entrances closed.

Greatest heat loss for a concrete slab floor that is poured on grade occurs at the edges. Rigid insulation with a thermal resistance of R-5 (at least 2 inches) should be placed around the entire perimeter of the slab.

In the wintertime the air is normally dry inside the house. This is a disadvantage because to be comfortable in dry air, people require a higher temperature than they would in a humid environment. Therefore, humidifiers--whether freestanding or built into the main duct of a warm air system--are a good investment for energy conservation. Humidfication also helps preserve home furnishings which may be adversely affected by an arid environment.

Keep the overhead door of an attached garage closed to block cold winds from infiltrating the connecting door between house and garage.

Fireplaces should have tightly fitting dampers which can be closed when the fireplace is not in use. Open dampers allow the natural draft of chimneys to pull warm air out in the winter, and cool air out in the summer. In the heating season, the water vapors emanating from bathing and cooking are beneficial because they help humidify the home. So, use the kitchen and bath exhaust fans sparingly.

Locate the heating thermostat on an inside wall and away from windows and doors. Cold drafts will cause the thermostat to keep the system running even when the rest of the house is warm enough.

Set the heating thermostat as low as comfort permits. Each degree over 68°F can add three percent to the amount of energy needed for heating. Each degree below 68°F can save about the same.

When entertaining a large group during the heating season, lower the thermostat a degree or two before the guests arrive. Otherwise, since people generate heat, the space may become wastefully overheated.

Close heating vents and radiator valves in unused rooms.

Make sure that registers for supply or return air are not blocked by drapes or furniture.

COOLING

Air-conditioners vary considerably in efficiency and, hence, in the amount of energy used. Therefore, select equipment on the basis of energy efficiency ratios (EER). The EER for window units or central systems is calculated by dividing cooling capacity expressed in BTU, by the electric power input, expressed in watts. As a general rule, an EER of 10 or more is excellent, 8 or 9 is good, and 6 or 7 is just adequate. Equipment with an EER below 6 should be avoided.

Seek professional help in determining the size of cooling equipment needed. Oversized units especially are to be avoided not only because they draw more energy than is necessary, but also because they cannot dehumidify properly which is detrimental to comfort.

Locate the compressor units of central air conditioning and heat pump systems in an outside area that is shaded by the house or by plantings. Units should be kept clean and free of any plant growth that would interfere with air circulation.

Direct sunlight falling on a window air conditioning unit increases its work load. When a choice is possible, locate such units on the north or shady side of the house.

Set the cooling thermostat as high as comfort will permit. The higher the setting, the more energy you save.

Attics must be ventilated to relieve heat buildup caused by the sun. When planning a new home, ask the architect to provide vents of proper size and location to insure attic ventilation by natural air flow.

For existing homes, determine whether or not attic ventilation is adequate and, if necessary, improve air flow by adding or enlarging vents.

When building a new house or refurbishing an old one, choose light colored roofshingles to reflect more of the sun's heat.

When cooling or heating systems are in operation, keep windows and doors closed.

Open windows during the moderate weather of spring and fall to admit outside air cooling instead of operating air conditioning equipment.

Close cooling vents and turn off window air conditioners in unused rooms. Keep doors to unused rooms closed.

Draw blinds, shades or drapes to block the sun light during the hottest part of the day.

Install awnings over windows exposed to direct sunlight.

In the cooling system, during the cooling season, run kitchen and bath exhaust fans only long enough to rid the house of unwanted water vapor, smoke and odors.

Don't position heat-producing devices such as lamps and TV sets beneath a wall-mounted thermostats for a central cooling system. Heat rising from the equipment could cause the thermostat to read a temperature higher than the true room temperature and lead to overcooling of the entire house.

FOOD KEEPING

REFRIGERATORS AND FREEZERS: Select refrigerator and freezer sizes that are just large enough for the family's needs. Operating energy is proportional to cubic feet of refrigerated space regardless of whether all of the space is utilized.

It is wise to keep refrigerators and freezers filled to capacity, but don't overcrowd to the point where doors cannot be tightly closed or air canot circulate freely around the foods.

Vacuum clean the condenser coils of refrigerators and freezers (in the back or at the bottom of the cabinets) every three months or so. Dust-covered coils impair the efficiency of compressor operation and increase energy usage.

Door gaskets on refrigerators and freezers should seal tightly against the frames to prevent infiltration of warm air. An easy way to check the condition of a gasket is by placing a dollar bill against the frame and closing the door on it. If the bill can be pulled out with a very gentle tug, or, worse still, simply drop out on its own, the door requires adjustment, or the gasket needs replacing.

Some of the newer refrigerators are furnished with a power-saver switch that controls a heating element imbedded in the walls of the cabinet. The element provides a small amount of heat that prevents moisture condensation around the edges of the door. Try turning the switch off, condensation, if any, may be slight and unobjectionable. If such is the case, save energy by keeping the switch off.

Before extended vactions, remove perishables from the refrigerator and turn to a warmer setting.

When buying a new refrigerator, look for the new energy-saving features such as a power-saver switch and improved insulation materials. These features can save as much as 15 percent in annual consumption of electricity.

Do not place uncovered liquids in refrigerators. In addition to absorbing undesirable flavors, the liquids give off vapors that add to the compressor work load.

Try to plan ahead and remove all ingredients for each meal at one time. Each time the door of a refrigerator or freezer is opened, its compressor has to run a bit longer to replace the cold air that spills out. Discourage leisurely open-door inspections of refrigerator contents by family members looking for between meal snacks.

Chest type freezers are less likely to lose cold air when doors are opened than upright freezers.

If possible, locate refrigerators and freezers away from direct sunlight and other warm air places, such as ranges and heating equipment.

COOKING

RANGE TOPS. If cooking is to be done efficiently, heat must be transferred from electric cooking element to food with minimum loss to the surroundings. To help do this, select pots and pans with absolutely flat bottoms. Spherical bottoms leave an air gap which provides a ready escape route for heat.

Use cooking utensils of the right size to completely cover the surface element. Whenever any part of the cooking coil is exposed, heat is wasted.

Expand the family menus to include stews and other single dish meals that can be prepared in a slow cooker or crock pot. Such meals require far less energy than those calling for the simultaneous use of the oven, plus two or three surface units.

Make more use of your pressure cookers. Pressure cookers cut food preparation time to one-third that required by conventional methods. Develop the habit of "lids on" cooking. Tightly fitted lids help keep heat within the utensils, permitting the use of lower temperature settings and shorter cooking time.

Reflector pans beneath stovetop heating elements should be kept bright and clean. Shinny pans help focus heat rays on utensil bottoms; dull or soiled pans absorb heat wastefully.

Carefully measure water used for cooking to avoid having to heat more than is really needed, when you put the kettle on, for instance.

Begin cooking on highest heat until liquids begin to boil. Then lower the heat control setting and allow food to simmer until fully cooked.

OVENS. When operating the electric oven, attempt to cook as much of the meal in it at one time as possible. Food with different cooking temperatures can often be cooked simultaneously at one temperature--variations of 25 degrees more or less still produces good results and saves energy.

When preheating an oven for baking, time the preheated period carefully. Five to eight minutes should be sufficient. There is no need to preheat for broiling or roasting.

Rearrange oven shelves before turning the oven on. To do this after the oven has preheated not only allows wasteful escape of heat, but poses a burn hazard as well.

Activate the self-cleaning cycle on an electric oven only for major cleaning jobs. Wipe up minor spills and splatters with a damp cloth. When self-cleaning is necessary (probably just a few times a year), start the cycle right after cooking while the oven is still hot, or wait until late evening hours when use of electricity is lowest.

Never use an open electric oven as a room heater or as a source of warm air for drying rain-dampened outerwear. If the kitchen is furnished with the type of refrigerator or freezer that exhausts warm air through a front floor-level grill, damp shoes can be dried quite nicely and at no energy cost by placing them on the floor near the grill.

Consider making one of the new microwave ovens your next major appliance purchase. Microwave ovens draw only about half the power of their counterparts in standard electric ranges and for a much shorter period of time.

Rather than using the oven for preparing small quanities of food, consider cooking in one of the small portable electric appliances such as a frying pan, grill or toaster/broiler. On the average, these use only about one-third the electric power of the oven broiler.

When roasting or baking, avoid making frequent progress checks that entail opening the oven door. Each time the door is opened, a considerable portion of the oven's heat escapes.

WATER HEATING

Locate water heaters as close to the points of hot water use as possible. The reason for this is that any hot water that remains in a supply pipe after a tap or valve is closed, eventually cools off and is wasted. The longer the supply pipe, the more heat loss.

When long lengths of hot water supply pipe are unavoidable, insulate them.

In sprawling ranchhouses or in residences with two or three levels, the rooms requiring hot water may be widely separated. It is possible to get better hot water service with less use of electricity by having two or more water heaters, one heater in each principle water-using area, instead of one heater in a central location.

Use the smallest practical diameter for hot water supply pipes to minimize heat loss and to reduce the volume of trapped water.

Repair leaky faucets promptly. A steady drip of hot water can waste many gallons per month and the energy needed to heat it.

Letting the water run while shaving or when washing dishes by hand is a needless waste. Avoid this by using sink stoppers and dishpans.

Encourage family members to take showers rather than tub baths. The average person will use about half as much water in a shower as in a bath.

The standby heat loss of a water heater increases temperature. So, set the temperature control of the water heater at a moderate 140°F, which is adequate for most domestic usage. If water of higher temperature is desired for certain functions such as dishwashing consider a dual-temperature system. Such systems employ a central unit supplying 140°F water for general purposes plus a second, smaller water heater in series with the first and set for 180°F.

Where possible, install a large capacity uninsulated tempering tank in the supply line to the water heater. A tempering tank raises the temperature of incoming water to building temperature prior to its entering the water heater. The higher the temperature of the water supplied to the heater, the less will be the energy needed to raise it to the desired tap temperature.

LIGHTING

Urge people to turn off the lights on leaving a room. This habit can be encouraged more easily when every area has its own wall switch (three-way switches for spaces having two entryways).

Provide "task" lighting (over desks, tool benches, sewing tables, etc) so that work and leisure activities can be carried on without illuminating entire rooms.

Select the type of lighting fixtures on the basis of their efficiency. Fluorescent lamps produce about four times as much light per watt as do incandescent bulbs.

The reflectance of interior surfaces has an important bearing on lighting efficiency. In home decoration, therefore, choose lighter colors for walls, ceilings, floors and furniture. Dark colors absorb light and would require higher lamp wattage for a given level of illumination. Light-colored surfaces should be kept clean to keep reflectance near like-new value.

Consider replacing incandescent lights in outdoor lighting fixtures with the new sodium vapor lights now available for residential applications. They consume less energy for a given light output and have a longer life span.

In lamps and fixtures having two or more sockets for incandescent bulbs, consider using a single large bulb in one socket rather than filling all sockets with bulbs of smaller wattage. A 100-watt bulb, for instance, produces 50 percent more light than four 25-watt bulbs for the same amount of energy.

Check the ratings of all incandescent light bulbs in the house. In many cases a lower wattage bulb can be substituted for the one now being used.

So-called "long life" bulbs emit less light than a standard incandescent bulb of the same wattage. So use them only where the long-life feature is advantageous, as in places that are hard to reach.

If possible, locate floor, table and hanging lamps in the corner of a room rather than against a flat wall. Lamps in corners reflect light from two wall surfaces instead of one, and therefore, give more usable light.

Clean lighting fixtures regularly. Dust on lamps and reflectors impairs lighting efficiency.

For large areas such as family recreation rooms where high levels of lighting are required periodically but not 100 percent of the time, install fixtures on two or three seperate circuits so illumation can be controlled by switching circuits on and off.

When purchasing light bulbs, the wattage rating tells you only the amount of power it takes to make a bulb work. The amount of brightness is measured in lumens. Larger wattage bulbs are usually more efficient, producing more lumens per watt than smaller bulbs. That's more light, and you consume less electricity.

To make sure that outdoor lighting is turned off during daytime, install photoelectric controls or timers.

LAUNDERING

WASHERS. Follow detergent instructions carefully. Oversudsing actually hampers effective washing action and may require more energy in the form of extra rinses.

Set the wash temperature selector to cold or warm as often as possible. Not all fabrics require extremely hot water for washing. As a matter of fact, some tests indicate that the new "cold water" soaps, almost all fabrics can be throughly cleaned in warm or cold water with considerable savings on the energy required for water heating.

It takes almost as much energy to run a lightly loaded washer as it does to cycle a fully loaded machine. Sort laundry and schedule washes so that a complete job can be done with a few cycles of the machine carrying its full capacity rather than a greater number of cycles with light loads.

With some machines the choice of a gentle or slow speed wash cycle is automatically accompanied by a slower speed spin for water extraction. Less drying energy will be needed if, after completing a gentle wash, the machine is reset by hand for an extra spin on high speed.

DRYERS. Avoid overdrying. This not only represents a waste of energy but harms fabrics as well.

Clean lint filters thoroughly after each complete drying cycle.

Ease ironing chores and conserve energy also be removing clothes from drum as soon as the dryer stops and before wrinkles have time to set. Clothes that are promptly folded or placed on hangers often need little or no ironing.

To save energy, try not to run the electric dryer unless it is carrying its rated poundage of clothes. Don't overload since this would cause excessive wrinkling and, perhaps, would require an added amount of ironing.

Locate dryer in a place which is ventilated with fresh dry air. Circulating, humid air through the machine increases drying time and the energy needed to run it.

GENERAL

Regularly clean or replace air filters on appliances (exhaust hoods, humidifiers, etc.). Clogged filters impair performance and cause the units to run longer.

Turn off T.V. sets that are not being watched. Children especially are likely to leave a set on when called outside to play or summonded at mealtimes.

Even when turned off, so called "instant on" TV sets draw some current to maintain selected circuits on standby readiness. Unplug sets having this feature when they won't be used for lengthly periods such as overnight or during vacations.

When it is time to shop for the next color TV set, look for the label "100 percent solid state". Solid state designs draw about one third less current than tube sets and, because they dissipate less heat, put a lighter burden on the cooling system.

First iron the fabrics that require lower temperature and work up to those requiring higher heat. An iron heats faster than it cools so it is quicker to go from low to high than the reverse. Less energy will be needed also.

Turn off the iron five minutes or so before all clothes have been ironed and finish ironing with the heat stored in the soleplate.

Always turn off the iron when work is interrupted by telephone or doorbell.

Store soiled dishes, glassware, etc., in the dishwasher until it is fully loaded. Dishwashers draw the same amount of power whether operated fully or empty.

A considerable share of the energy needed to run a dishwasher is used by the electric heating element for drying. When time permits open the dishwasher door at the end of the rinse phrase to permit dishes to dry by natural convection. Some new machines feature a push buttom control for bypassing the dry portion of the cycle.

Most swimming pool owners operate their filtering systems many more hours than necessary. Make more frequent checks of water condition and run filters just long enough to maintain clarity.

Many blower type hair dryers consume as much energy as an electric toaster and for longer periods. Consider toweling as a healthful energy saving alternative but in any case, avoid over drying.

Don't use hot water when operating the food waste disposer in the kitchen sink. Using cold water not only saves energy but is preferable because it solidifies grease which is then ground up and flushed away.

What we have told you in this booklet all adds up to indirect savings of large amounts of energy, especially in areas where oil and natural gas are used to generate electrcity. These savings can help to stretch out our nation's dwindling supply of these two resources until coal, nuclear power and other energy sources can take up the slack.

And by using electricity wisely, not wastefully, you will be helping to control your electric bill without sacrificing your comfort or convenience.

IT'S EVERYONE'S JOB!!!

Materials: The below typed on a ditto for each student.

DIRECTIONS: Have each student complete individually or in small groups. If desired, it may be discussed when complete.

For Ditto:

It's Everyone's Job!!! Read the idea for conserving energy in the column headed CONSERVATION METHOD. Then, answer the questions in the space provided.

CONSERVATION METHODS	What energy resources does this save?	Does it use less energy?	How can we encourage this conservation measure?
1. Flying passenger planes only when airplanes are full	Petroleum	YES	
2. Shipping freight by train instead of truck	Petroleum	YES	
3. Replacing incandescent light bulbs with fluorescent lights	Coal, Natural gas, Petroleum	YES	
4. Reducing heating and cooling where space is unoccupied	Natural Gas, Petroleum	YES	
5. Recyling steel paper, glass, and aluminum	Coal, Natural gas, Petroleum	YES	
6. Developing and using mass transit systems	Petroleum	YES	

WHAT CAN YOU DO TO SAVE ENERGY?

Materials: The following could be typed onto a ditto.

Directions:

Each student can do Part 1 individually. Part 2 may be done individually or as a class. If done as a class you may want to draw a copy of the graph on the blackboard or overhead.

PART 1:

1. Brenda's mother and Jerry's father each work ten miles away from their homes. In a five-day week, each uses five gallons of gas driving to and from work. Jerry's father drives alone. Brenda's mother is in a carpool in which she takes four other persons to work. If each of her passengers drove, each would also use five gallons of gas a week. Now that they carpool, how much gasoline does Brenda's mother help save each week? (20 gallons) ; each year? (1040 gallons) . How could Jerry's father help save energy? (form a carpool) .

2. The Miller's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11:00 each night. How might they do this without wasting energy? (install an inexpensive timer that turns the lights on and off.

3. Bob and his sister are going to wash clothes. He wants to do his two shirts by themselves. She wants to do them with her four blouses. Which way will conserve energy? (washing them together). Why? (more efficient use of water, soap and electricity).

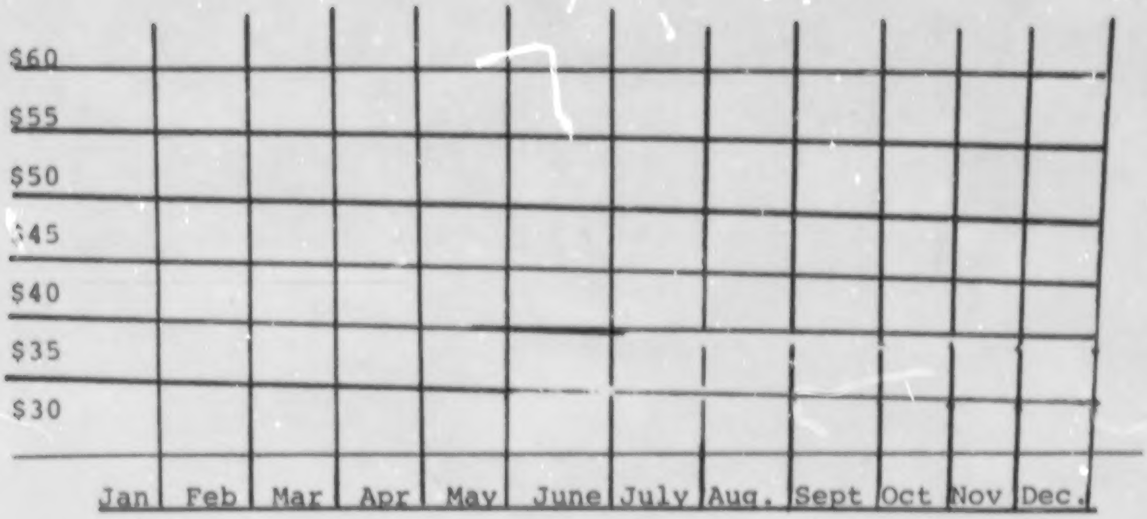
4. Jason has just come inside after playing in the snow and feels too warm. He wants to turn down the thermostat until he feels comfortable. His mother tells him to leave it where she has it set as 68 degrees. Which would be more energy conscious? (leaving it in one place)

PART 2:

Below are the Johnson's heating and air conditioning bills for two different years. In 1976, they had no insulation in their home. At the end of the year, they had some installed so the cost of heating and air conditioning in their home went down. In the graph below, place a dot for the cost of each month's in 1976. Then draw a line between the dots. Do the same thing for 1977 in red. Compare the Johnson's savings with insulation.

How much did they save in January? (10.00)
How much did they save for the entire year? ($80.00)

	1976	1977
JANUARY	$55	$45
FEBRUARY	$45	$40
MARCH	$40	$40
APRIL	$40	$35
MAY	$35	$30
JUNE	$45	$35
JULY	$60	$45
AUGUST	$55	$40
SEPTEMBER	$40	$35
OCTOBER	$35	$35
NOVEMBER	$40	$35
DECEMBER	$45	$40



1. At what time(s) of the year is there the highest utility cost? (January and July)

   Why: (Coldest and hottest months)

2. At what time(s) of the year is there the greatest savings after insulation? (July and August)

NOTE:

An individual student project similar to Part 2 could be done by someone whose own home has recently been insulated, or if they know of someone they can get similar information from.

UNSCRAMBLE THESE SENTENCES

MATERIALS: These sentences could be put on a ditto for each student or written on the blackboard or overhead.

DIRECTIONS: These sentences may be unscrambled individually or as a class.

1. dryer do over load not clothes
2. less water baths showers use than
3. rinse after air dry dishes in dishwasher
4. loads use full washing machine in
5. television turn when off not watched being
6. loads in dry clothes consecutive
7. can save carpools gasoline
8. can help I save energy

FACT OR OPINION

MATERIALS: Prepare statements below on a ditto for each student.

DIRECTIONS: Students will individually complete the handout. If desired, any or all of the statements may be discussed as a class.

DITTO: Circle F if a statement is a fact. Circle O if a statement is opinion.

F O 1. Using the warm wash setting on automatic washers instead of the hot setting saves energy.

F O 2. Washing clothes in cold water with cold water detergents saves energy.

F O 3. Washing dishes by hand instead of in the dishwasher saves energy but it's too hard, and takes too much time.

F O 4. New homes can be designed to make maximum use of natural light throughout the year.

F O 5. Fossil fuels such as oil and coal will run out sometime in the future.

F O 6. During winter, opening draperies during the afternoon and closing them at night saves energy.

F O 7. Small cars save energy but are ugly and uncomfortable.

F O 8. Fireplaces are an inefficient means of heating.

F O 9. Petroleum is the major energy source for the U. S.

F O 10. Recreation is a major energy consumer.

F O 11. The government should regulate the amount of energy everyone uses.

F O 12. Gas rationing is the best way to save gas.

F O 13. Cooler showers save energy.

F O 14. I shouldn't have to change my lifestyle to save energy.

F O 15. Air conditioning is a luxury we can't give up.

ANSWER KEY:

1. F
2. F
3. O
4. F
5. F
6. F
7. O
8. F
9. F
10. F
11. O
12. O
13. F
14. O
15. O

Public Attitudes Influence Consumer Products

Materials Needed: Access to a media center containing bound periodicals for the past 10 - 15 years.

Activity: Individually, or in small groups, students will examine automobile advertisements over a period of at least 10 years. They then will identify how automobile construction and advertising has changed as the public has become more aware of energy limitations. They may make a list or write a paragraph regarding their conclusions.

EVALUATION SUGGESTIONS

Evaluation during the unit and at the end of it is up to the individual teacher.

It is suggested that each student take the energy inventory at the end of the unit and compare the results with the answers given when the inventory was taken was taken during the general overview.

It is suggested that each student answer the following:

1) What was your attitude toward saving energy when you started this unit? How has it changed? Explain in complete sentences.
2) What are you going to do to help conserve energy?
3) Explain how your values influence the amount of energy you use.

SOLAR ENERGY IN THE HOME

by

Allen A. Roeder
James A. Woodland

Grade Level: 10-12
Time Required: 5-7 Periods
Recommended Subject: An excursion into passive solar technology for physical, earth, or general high school science courses.

Prepared for
the Nebraska Energy Office

SOLAR ENERGY IN THE HOME

ABSTRACT: In this learning package, you will investigate the home solar energy alternatives. Through selected readings, and an investigation, the student will become aware of passive solar technology that is available today.

RECOMMENDED LEVEL: Senior High School

TIME REQUIRED: Five days to seven days

MAJOR TEACHING STRATEGIES: Selected readings, laboratory and class discussions.

ESSENTIAL ADVANCE PREPARATION:

Read: Solar Energy -- A Status Report
DOE, June, 1978.

Solar Energy, by William W. Eaton

Obtain: Filmstrip "Harnessing the Sun", National Geographic number 03249.

Materials as specified in heat retention laboratory.

GOALS:

1. Students should realize that solar energy is a viable alternative to the use of fossil fuels for home heating.
2. Students will become familiar with basic solar technology.
3. Students will become aware that solar technology is being applied in the world today.
4. Students will become familiar with factors which influence the selection of solar home location and materials.

BEHAVIORAL OBJECTIVES:

1. The student will name 3 advantages of solar energy.
2. The student will name 2 factors limiting solar energy usage today.
3. The student will list 4 factors affecting heat retention.
4. The student will name 2 materials with good insulating properties.
5. The student will list 3 factors to be considered when orienting an energy efficient home.
6. The student will describe 2 applications of trees in an energy efficient home design.

Behavioral Objectives (cont).

7. The student will demonstrate an understanding of the following solar energy technologies:

    1. Heating and cooling,

    2. Photovoltaic conversion,

    3. Biomass conversion.

LESSON PLANS:

Day 1

1. Show filmstrip -"Harnessing the Sun"
2. Discuss ancient to modern uses of solar energy.
3. Assign reading "Introduction to Solar Energy" from student materials packet.

Day 2

1. Discuss advantages and disadvantages of using solar energy.
2. In class reading of "Solar Heating and Cooling" from student materials packet.
3. Discussion of reading.
4. Pre-lab -- Heat Retention.

Day 3

1. Laboratory -- Heat Retention.

Day 4

1. Post-lab -- Heat Retention.
2. In class reading of "Energy Efficient Home Design for the Energy Conscious Consumer" from student materials packet.
3. Discussion of reading.
4. Assign reading of the following pamphlets:

    a. Solar Electricity from Photovoltaic Conversion,
    b. Fuels from Biomass,
    c. Water Power

Day 5

1. Class discussion of photovoltaic conversion, biomass fuels, water power and other solar energy applications.

EVALUATION SUGGESTIONS

Teacher designed evaluations used at teachers discretion.

OPTIONAL: Have the student design a solar energy efficient home considering the following factors:

1. Orientation of home on building site,
2. Use of natural landscaping,
3. Building materials and insulation,
4. Home should be a pleasant place for human habitation.

If you use this method of evaluation, you will need to allow more time for this packet.

INTRODUCTION TO SOLAR ENERGY

"The heat of the universe is produced by the sun"
Leonardo Da Vinci

Da Vinci was fairly accurate in his statement about our source of heat. We know now that there are billions of suns heating the universe. If we go back in time from when the mythological Prometheus first stole fire from heaven to modern man's burning of fossil fuels, we become aware of the sun as man's ultimate source of energy.

Sunshine is composed of electromagnetic waves. These waves travel through space at the rate of 300,000 kilometers per second. The three main waves are invisible infrared, visible light, and invisible ultraviolet.

Ultraviolet light has a wavelength shorter than visible light. It can be of benefit to man, aiding in the formation of vitamin D, and sterilization of some pathogens. Overexposure to ultraviolet radiation is harmful causing sunburn and skin cancer. Most of the ultraviolet light is absorbed by the earth's atmosphere.

Infrared waves are longer than visible light. These are heat waves which can readily pass though the atmosphere but are absorbed by glass and water.

Visible light is that part of the electromagnetic spectrum which we can see. Most visible light waves reach the earth's surface where they are absorbed and converted into heat. This heat is then reradiated back into the atmosphere in the form of infrared radiation. This radiation is readily absorbed by carbon dioxide and water vapor thus warming the earth's atmosphere. Note that the atmosphere is heated directly by heat radiation from the earth and only indirectly by the energy of sunlight. This is known as the greenhouse effect and is one of the main principles of solar heating.

Photosynthesis is the link between the sun, food, and fossil fuels. It is the process by which plants use sunlight to manufacture carbohydrates from water and carbon dioxide in the presence of chlorophyll. This is the begining of the food chain. Fossil fuels are the plant and animal remains which have been turned into coal, petroleum, and natural gas by the slow action of heat, pressure, and aging. This source of stored sun energy supplies 95 percent of the energy used by civilized man. Although reports on reserves differ, they all agree that someday, early in the next century, man will have used up the earth's supply of petroleum and natural gas. This leaves coal as our only remaining fossil fuel. Of the three fossil fuels, coal causes the greatest amount of pollution when burned.

Since man is using fossil fuels faster than nature can replenish them, he must produce alternative sources of energy. Conservation methods and improved technology for recovery of fossil fuels only increase the life of our reserves. They do not solve the ultimate problem of what to do when they are depleted.

Man has made use of solar energy in the past. Wind, caused by unequal amounts of sunlight falling on different geographical locations, provided man with the energy needed to move ships around the world, and to turn windmills to provide energy for various tasks. The sun also produced combustible materials such as wood for production of heat energy. Man has also been aware of the two main disadvantages of direct solar energy. The first is that sunlight is diffuse. It is spread out and must be collected by some means. The second drawback is sunlight is intermittent. It is only available during clear days. This creates two problems for scientists to resolve. One is to develop a way to store solar energy for later use and the other is to convert sunlight into energy economically.

When man resolves these problems he will realize the three major advantages solar energy has over nuclear, fossil fuels, and hydroelectric power. First, solar energy is readily available throughout the world. Unlike nuclear and fossil fuels, sunlight is not found in concentrated areas scattered over the earth's surface. This results in fewer problems of distribution and prevents the exploitation of one country by another. The second advantage is that solar energy is almost inexhaustable. The estimated solar energy reserve is five billion years, the life expectancy of the sun. Finally, solar energy is non-polluting. Solar power generation does not produce any by-product which decreases the environment's ability to support life.

By applying the greenhouse effect and the absorbtion and reflection of light by light and dark surfaces the technology already exists for space and hot water heating. Photovoltaic cells have the capability to convert sunlight into electricity. At present they are hand crafted and inefficient, making them an expensive source of electric power. The technology is being developed for mass-production and to increase their efficiency. With this in mind solar energy will be a practical energy source for the home.

HEAT RETENTION INVESTIGATION

PURPOSE: To compare the heat retention of different substances.

MATERIALS:

4	250ml beakers
4	thermometers
100	ml water
100	ml sand
1	timing device
100	ml each of two different substances
1	light source with relfector and 200-250 watt bulb.

PROCEDURE:

1. Place 100 ml of each substance in a separate beaker.
2. Put a thermometer in the center of each substance. (NOTE: The bulb should be buried in the substance and the water thermometer bulb should be shielded from the light source)
3. Set the four beakers equil distance (10 cm) from the light source.
4. Read and record the initial temperature reading.
5. Turn on the light source.
6. Record temperature readings every minute for 10 minutes.
7. After 10 minutes, turn off and remove the light source.
8. Continue recording temperature every minute for an additional 20 minutes.
9. Plot your data on one graph with temperature as a function of time.

QUESTIONS:

1. Why is it important all containers are equidistant from the light source?
2. Why is it important that you have the same amount of each substance?
3. Which substance absorbed heat the most rapidly?
4. Which substance absorbed heat the least rapidly?
5. Which substance lost heat the most rapidly?
6. Which substance retained heat longest?
7. What factors affect a substance's ability to gain or lose heat?
8. Based on your data, which substance would be most ideal for use in a solar home and why?

TEACHER NOTES:

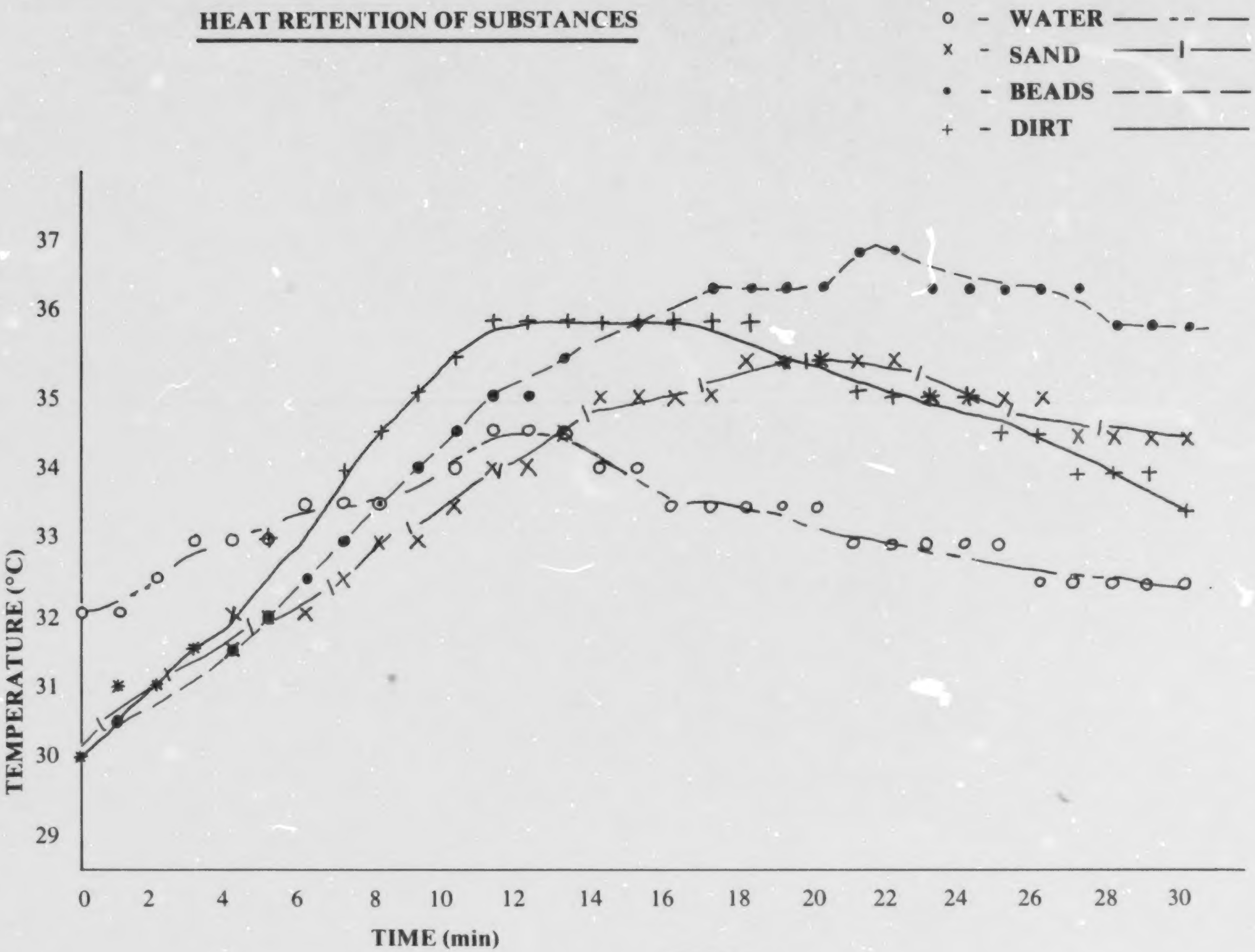
You will need to supply or have each student group bring in 100 ml of two different substances for testing in this experiment. Most ideally, there should not be any duplication of these materials. Anything they would like to try should be allowed. Perhaps they may discover a new insulator.

A set of sample data, graph, and the answers to the questions asked in the investigation are given. Students should use the slopes of the lines on the graph to interpret the results of the experiment.

DATA:

TIME (min.)	TEMPERATURE (°C) water	sand	beads	dirt	
0	32.0	30.0	30.0	30.0	
1	32.0	31.0	30.5	31.0	
2	32.5	31.0	31.0	31.0	
3	33.0	31.5	31.5	31.5	
4	33.0	31.5	31.5	32.0	LIGHT ON
5	33.0	32.0	32.0	33.0	
6	33.5	32.0	32.5	33.0	
7	33.5	32.5	33.0	34.0	
8	33.5	33.0	33.5	34.5	
9	34.0	33.0	34.0	35.0	
10	34.0	33.5	34.5	35.5	
11	34.5	34.0	35.0	36.0	
12	34.5	34.0	35.0	36.0	
13	34.5	34.5	35.5	36.0	
14	34.0	35.0	36.0	36.0	
15	34.0	35.0	36.0	36.0	
16	33.5	35.0	36.0	36.0	
17	33.5	35.0	36.5	36.0	LIGHT OFF
18	33.5	35.5	36.5	36.0	
19	33.5	35.5	36.5	35.5	
20	33.5	35.5	36.5	35.5	
21	33.0	35.5	37.0	35.0	
22	33.0	35.5	37.0	35.0	
23	33.0	35.0	36.5	35.0	
24	33.0	35.0	36.5	35.0	
25	33.0	35.0	36.5	34.5	
26	32.5	35.0	36.5	34.5	
27	32.5	34.5	36.5	34.0	
28	32.5	34.5	36.0	34.0	
29	32.5	34.5	36.0	34.0	
30	32.5	34.5	36.0	33.5	
AT --	-1.5	-.5	-1.0	-2.5	

HEAT RETENTION OF SUBSTANCES



Teachers Notes Cont.

ANSWERS TO QUESTIONS:

1. So they all receive the same amount of radiation.
2. The mass of a substance will affect heat loss or gain.
3. Depends on student data
4. Depends on student data
5. Depends on student data
6. Depends on student data
7. Color, chemical composition, air space between particles, density, surface area, surrounding air currents, etc.
8. Depends on data; the resistance to heat gain or loss would be a prime factor in answering this question. Encourage student discussion on this question. (practicality, availability, special handling problems, price, etc.)

ENERGY-EFFICIENT HOME DESIGN FOR THE ENERGY CONSCIOUS CONSUMER

An energy efficient home incorporates passive design ideas and/or solar energy systems in its planning, design, construction and use, in addition to such conventional energy conserving features as insulation in the right places, double glazing of windows and weatherstripping at all openings.

"Passive design ideas" are defined as design approaches or ideas that:

1. use solar energy naturally,
2. contain little mechanical hardware,
3. require little or no energy themselves,
4. usually are low in cost.

Nature is our ally, in efficient home design. We must understand that builders should consider what nature dictates, and not always what style might dictate. To build energy efficient homes is to understand both the assets and liabilities of the natural environment. Without this understanding, our homes will be at war with natural forces when peaceful co-existence would be more advantagious both ecologically and economically.

The energy efficient home will be designed with some basic facts in mind. The design must consider proper site location and position, earth and landscape buffers, careful use of glass and natural ventilation. Preceeding any design,correspondence with the nearest weather bureau is a must. If the home is going to work with nature, you must first get to know nature.

Nebraska, because of it's location and geography, is treated to wide differences in weather conditions; from stifling heat to bone chilling cold. Winds cross our predominately flat plains with little or nothing to stop or detour them. Consistant weather conditions may be the rule in the far north or south, but Nebraska gets it's share of both the best and worst from both locations. The Nebraska home must be designed to withstand the extreme effects of these climatic variations.

There are methods for using what nature has already provided. For example, one might build an underground home and heat it with an open fire. You could select a site abundantly dotted with large shade trees. You can avoid a windy hilltop and find shelter on the side hill. You can look for a nearby pond or lake to serve as a natural cooling system in the hot summer months.

Although it might be best to utilize nature exactly as you find it, it may not always be practical to do so. The underground cave may not provide the open airy feeling that you desire, you may want an outside view and you might not want to be tied down feeding a wood burning stove. Trees may not always be growing where you would like them to be and a nearby pond or lake may be even more difficult to find.

There are, however, ways to use nature to your advantage without letting nature take advantage of you. In selecting a site, consider the slope of the land, the direction the home will face, and trees as possible windbreaks.

In a rural setting, try to select a location with the land sloping slightly to the south. Position the home so that the winter winds will strike the back of the house. Plan your view from the southerly exposure so that windows on the north side will be few in number, small in size and functional for ventilation. Summer winds tend to come from the south, with this design, you can use the cooler winds of evening and night to remove the built up heat of the day. If a directly south facing home is not possible, a shift to a more easterly direction is better than going to the west because a west facing home will tend to be over heated by direct rays of the sun in the hottest part of a summer day.

With or without a southerly slope to work with, consider the wind breaking effect of trees located to the north of the home. Wind travels approximately five times the height of the highest obstacle it has to pass over. Therefore, if the trees to the north of the home are 20 feet tall, the wind will travel over the trees and continue to travel "high" for appxomately 100 feet. (f times 20 equals 100 feet). Your home is therefore protected from the brunt of the wind if it is located within 100 feet of the trees. Coniferous (ever-green) trees are best for a northerly wind break because they do not lose their leaves.

A city building site has its own special problem area of which to be aware of. You should strive for a southern front exposure. Be aware of other structures surrounding your lot that may block out the sun. A solar efficient home is of little value if the sun never shines on it. Unusual wind currents may tunnel around other structures and strike your house continuously. You must observe these conditions yourself; the weather bureau cannot help you with isolated conditions. Trees become even more important in cities by moderating not only winds, but temperatures carried by the concentration of hard surfaces--streets and buildings more closely massed.

Building of the energy efficient home is geared for all seasons. As we plan for reduced fuel usage in the cold months, we are also planning for a comfortable indoor enviornment during the hottest summer months. In all aspects of construction and material usage, natural forces will again be taken into account.

We usually think of insulation to keep warm air in and cold air out, insulation also works by increasing your home's resistance to outside heat. A well insulated home, even with outside temperatures as high as 98°F, should stay cool until early evening when (hopefully) cooler winds and natural ventilation will remove the accumulated heat.

Before you buy any insulation, shop around. Read the accompanying literature on all types of insulation. You will usually see reference made to "R value". R values refer to a material's ability to retard the flow of heat; the larger the R value, the more the material resists heat flow. R values are additive. If one inch of the material has an R value of 4, then two inches of the material has an R value of 8, and so forth.

As the cost of fuels continues to increase, so does the optimum R or resistance overall for your home. Now an overall resistance of 20 is considered sufficient, however, going to an even higher overall resistance of 25 or 30 may be a wise long-term investment. Remember that it is much less expensive and difficult to add sufficient insulation while constructing a home than to add it later.

Nebraska's recommended "R" ratings:

Ceiling = 25 - 35
Walls = 16 - 22
Floors = 13 - 25

When planning your home's insulation needs, remember to consider the direction the walls are facing. The south wall probably will not require as much insulation as the north wall. If your site location took wind currents into consideration, you are ahead of the insulation game. It is much better to prevent high velocity winds from reaching the surface of your structure than to try to insulate against these winds.

No matter how well insulated your dwelling may be, how well sheltered from the wind it may be, about 50% of the total indoor heat is lost through air infiltration. A general tightening up of your home is required to save this otherwise wasted heat. This is true of both new construction and older dwellings. Weatherstripping is required around doors and windows. All cracks in walls and the foundation should be caulked as well as all areas around non-opening windows. During winter heating or summer cooling seasons, close off all unused hallways and rooms and weatherstrip these inside doors.

Windows lose from 5 to 10 times more heat per square foot than do walls or ceilings. The importance of taking action to reduce this tremendous waste of heat cannot be overstressed.

Traditionally, windows have been oriented to face the street or road. Windows in an energy efficient home should be oriented to the sun as well as to the need for light and the floorplan of the room. Your largest windows should be on the south wall, where they can capture the warming rays of the winter sun. Of course in the summer, the warm rays are not wanted, so the home design must incorporate an overhand above these windows that will block the high summer sun but not the low winter sun. Trees may also play a role in your energy efficient design again in this area. Large trees that provide welcome shade in the summer and drop their leaves in the fall to allow the winter sunshine to pass are an obvious and attractive addition to your southern exposure.

To decrease heat loss through existing windows, add storm windows or double panes of glass if they are not already there. Caulk and weatherstrip around all cracks no matter how small. Movable insulating shields, thermal curtains or hinged insulating shields or shutters should be placed over windows at night in the winter.

A small foyer may be added to your design. (a foyer may also be added quite readily to an existing structure). This foyer will create a still air space that will drastically reduce the amount of cold air that enters the house (or leaves in the summer) when the door is opened or closed. This small cost addition to your design (or present home) will greatly improve your home's total energy efficiency.

Natural cooling of your home occurs when cool air is allowed to enter and replace warm air. If you increase the velocity of the air passing through your home, you will increase the cooling effect. If the inlet is the same size as the outlet, the cooling effect will be the same as a gentle breeze, however, if you reduce the size of the inlet to 1/2 the size of the outlet, your air movement will be rapid enough to provide comfort even on highly humid summer days. (Don't worry, you still will not generate an "in house" tornado).

Position your vents so that the intake vent is on the windward (the side that the wind hits) side of the house and the outlet is on the leeward (sheltered) side. In many areas the prevailing wind direction changes from day to night. If you live in such an area, locate your inlet vents on the side of your home where the cool evening breezes originate. The cool air will enter the low inlet vents and force hot air out of the high outlet vents. Shrubs shading (not blocking) your inlet vents will increase their cooling effect.

Passive solar collectors are simply windows and masonry elements located on the south side of your home. Although these items may seem simple, if they are incorporated into a well located and insulated home, they can provide from 15 to 100 percent of your heating needs directly from the sun; when the sun is shining.

Masonry floors and walls do an excellent job of storing the sun's heat. If the floors are brick or concrete, allow the sun to shine on uncarpeted areas. These areas will absorb the sun's heat and return it to your house throughout the day and into the night.

A masonary wall will also store heat. Sun will strike the back of a south room early in the morning and late in the afternoon. While a masonary wall can be structurally functional, it can also be strikingly beautiful if so designed. As a heat absorber, the masonary wall allows you to increase the amount of south-facing windows without overheating your interior in the daytime. If your interest leads you in such a direction, this wall might incorporate a large aquarium, the water in which provides excellent heat~~ing~~ holding abilities. You might even use the aquarium to provide a source of high quality protein for your family.

Adding a greenhouse to your home provides both additional winter heat and a suitable environment to grow food and/or flowers all year long. If you want a green house, it is substantially less expensive to add it to your home rather than to build a seperate structure. Add your greenhouse directly to your south-facing wall. The heat stored in the masonary or rock floor of your greenhouse can be moved into your house with a small fan if necessary. Again, shutters or insulating curtains are needed to retain heat at night.

Heating with wood is another solar supplement that you may want to consider as a part of your design. A fireplace, while aesthetically pleasing is not an energy efficient device and therefore is not for your energy efficient home. Air-tight wood burning stoves, however, are extremely efficient heating devices, and most of them now provide for viewing the flames just as with a fireplace.

RESOURCES

Except where noted, a classroom set of 30 of each of the materials listed below is required.

MATERIALS WRITTEN FOR THIS UNIT

"Introduction to Solar Energy"

"Energy Efficient Home Design for the Energy Conscious Consumer"

"Heat Retention" Laboratory

PAMPHLETS

Factsheet #7. Solar Heating and Cooling. National Science Teachers Association, 1977

Fuels from Biomass. United States Department of Energy, 1977.

**Ocean Thermal Energy Conversion. U.S. Department of Energy, 1977.

Solar Electricity from Photovoltaic Conversion. U.S. Department of Energy, 1978.

**Solar Energy. Eaton, William W. Energy Research and Development Administration, 1976.

**Solar Energy--A Status Report. U.S. Department of Energy, June 1978.

Water Power -- Use of a Renewable Resource. U.S. Department of Energy, 1978.

FILMSTRIP WITH CASSETTE

***Harnessing the Sun. National Geographic Society. #03249, 1977. 13 minutes

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** Only one copy is needed of this resource for teacher background reading.

***Only one copy of this resource is required for class viewing.

SUPPLEMENT

BOOKS:

Build-it Book of Solar Heating Projects. Foster, William F. Tab Books, 1977

Supplement (cont)

Design for a Limited Planet. Skurka, Norma and Jon Naar. Ballantine Books, 1976.

Energy: Global Prospects 1985-2000. Workshop on Alternative Energy Strategies. McGraw-Hill Book Co., 1977

Natural Solar Architecture: A Passive Primer. Wright, David. Van Nostrand Reinhold Co., 1978.

MAGAZINES

National Geographic. Volume 149, Number 3, March, 1976.
Better Homes & Gardens. Volume 57, Number 3, March, 1979.

PAMPHLETS

Energy Conservation with Windows. Federal Energy Administration.

Energy-Efficient Building Design. Wynnyckyj, Paula. University of Nebraska Press, 1977.

Passive Design Ideas for the Energy Conscious Consumer. National Solar Heating and Cooling Information Center.

STUDENT MATERIALS PACKET

To contain all materials specified under "Resource"

GASOHOL

Grade Level
Jr. or Sr. High

Subject
Chemistry-Biology

Time
One Week

an

Energy Alternative

Energy Unit
by

1. Dan Haase - Oakland, Nebraska
2. R. Stephen Skinner - Millard, Nebr.
3. Ronald G. Crampton - Omaha, Nebr.

Prepared for
the Nebraska Energy Office

GASOHOL
AN
ENERGY ALTERNATIVE

Teaching Unit By:

1. Dan Haase - Biology Teacher,
   Oakland, Nebraska

2. R. Stephen Skinner - Chemistry
   Teacner, Millard, NE

3. Ronald Crampton - Chemestry Teacher,
   District 66

1. **ABSTRACT:** This unit was designed to produce an awareness of Gasohol as an energy alternative. Gasohol is a blend of 10 percent pure ethanol and 90 percent unleaded gasoline. The unit consists of:

   A. A factsheet on Gasohol

   B. A list of advantages and disadvantages of Gasohol use.

   C. A worksheet of problems related to Gasohol

   D. Laboratory experiments
      1. Fermentation
      2. Distillation
      3. Heat of Combustion

   E. A resource list of additional activities.

   F. Supplementary materials.

2. **RECOMMENDED LEVEL**

   This packet is recommended for senior high school chemistry students with a biology background.

3. **TIME REQUIRED**

   The minimum suggested time for this unit is one week.

4. TEACHING STRAGEGIES

The strategies for this unit include:

A. Class discussion of pros and cons of Gasohol as an energy alternative.

B. Assigned reading on Gasohol

C. Experiments dealing with Gasohol

D. A worksheet related to Gasohol

E. Reevaluation of Gasohol as an energy alternative

5. ESSENTIAL ADVANCED PREPARATION

A. Contact:
Agricultural Products Industrial Utilization Committee
301 South Centennial Mall
Lincoln, Nebraska 68509

PHONE: (402) 471-2941

Request those articles marked with an asterik in the Resource/Bibliography List, located in this packet.

B. The grain fermentation experiment should be started prior to the beginning of this unit.

C. Obtain a free copy of "An Appraisal of Energy Utilization In Nebrasksa" by John E. Lagerstrom.

Contact:
Education Coordinator
Nebraska Energy Office
P. O. Box 95085
Lincoln, NE 68509

PHONE: (402) 471-2867

6. GOALS

The goals for this unit are:

A. To make students aware of energy resources and alternatives.

B. To make students specifically aware of the use of Gasohol as an energy alternative.

C. To show students that biological and chemical principles can be applied to the study of Gasohol.

7. BEHAVIORAL OBJECTIVES

At the end of this unit students should be able to:

A. State their position on the use of gasohol and justify this position with factual material.

B. State the difference between complete and incomplete combustion.

C. Discuss the role of fermentation in the production of ethanol from grains.

D. Separate ethanol from a fermentation solution by distillation.

E. Calculate the heat of combustion of ethanol using experimental data.

8. CLASSROOM ACTIVITIES RECOMMENDED

Activities done in the order shown below are the recommended classroom activities for this unit.

A. Discussion of Nebraska's energy use; past, present, and future, based on Appendices 1, 2, and 3. These are located in the Supplement to this unit.

B. Discussion of energy alternatives with the focus on Gasohol. See Appendices 4 and 5.

C. Discussion of pros and cons of Gasohol use. (Found in this packet.)

D. Fermentation experiment. (Found in this packet).

E. Distillation Experiment (Found in this packet.)

F. Heat of combusion experiment (Found in this packet.)

G. Distribution of the worksheet as a homework assignment with disussion of solutions to the problems. (Found in this packet.)

H. Final evaluation of Gasohol as an energy alternative.

I. Use of various activities found listed as additional activities in this packet.

9. EVALUATION SUGGESTIONS

It is recommended that each teacher utilizing this packet develop evaluation items consistent with their own teaching style. Additionally, it is recommended that a pre and post opinion poll of student attitudes toward Gasohol use be developed by each teacher.

Resource List - Bibliography

1. "Gasohol: energy mountain or molehill", by Earl V. Anderson Chemical & Engineering News, Volume 56, Number 31, July 31, 1978, Pages 8 - 15.

2. "Alcohol: A Brazilian Answer to the Energy Crisis", by Allen L. Hammond, Science, Vol. 195, Feb. 11, 1977, pages 564 - 566.

*3. "The Production or Ethanol by the Fermentation of Grain" by Dr. Wm. Scheller, paper presented at the International Symposium on Alcohol Fuel Technoloby. November 12 - 14, 1977.

4. "Alcohol for Gasoline", by Jeanne Schinto, The Progressive, November 1977, pages 46 - 49.

5. "An Appraisal of Energy Utilization in Nebraska", by John E. Lagerstrom, free from The Nebraska Energy Office
Education Cooridinator
Box 95085
Lincoln, Nebraska 68509

6. "About using Alcohol as a Fuel for Automobiles", in U.S. News & World Report, Jan. 16, 1978 page 51.

7. "eXXon? When whiskey is cheaper than gas, mass transportation may have a chance." Forbes, Sept. 15, 1975, page 23.

8. "View From Abroad-Brazil Grows Its Motor Fuel", by Fradleu Garner, Enviroment, Vol. 20, No. 1, Jan./Feb. 1978, page 5.

*9. "Gasohol-Food and Fuel for the Future", paper by Charles Fricke, Brochure published by the Agricultural Products Industrial Utilization Committee.

*10. "Grow Your Own Gasoline", The Country Gentleman, by Tom Cox, Winter 1976.

*11. "Energy and Ethanol", by Dr. Wm. A. Scheller, Dept. of Chemical Engineering UNL, testimony presented on Gasohol Chicago, Illinois, April 6, 1978.

*12. "Tests on Unleaded Gasoline Containing 10% Ethanol-Nebraska Gasohol", by Dr. Wm. A. Scheller, Dept. of Chemical Engineering UNL, paper presented at Wolfsburg, Federal Republic of Germany, November 12 - 14. 1977.

Resource List on Gasohol continued:

*13. "Nebraska 2 Million Mile Gasohol Road Test Program Sixth Progress Report", By Dr. Wm. A. Scheller, January 31, 1977.

*14. "Net Energy Analysis of Ethanol Production " by Dr. Wm. A. Scheller, and Brian J. Mohr, paper presented at the 171st National Meeting of the American Chemical Society New York, New York, April 7, 1976.

*15. "Protein Concentrates From Distillers By-Products", by Dr. Wm. A. Scheller and Brian J. Mohr, paper presented at the Ninth National Conference on Wheat Utilization Research Seattle, Washington, Oct. 8-10, 1975.

*16. "Agricultural Alcohol in Automotive Fuel-Nebraska Gasohol", by Dr. Wm. A. Scheller, paper presented at the Eighth National Conference on Wheat Utilization Research, Denver, Colorado, Oct. 10-12, 1973.

* For copy of this reference contact:

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11. Supplement

Appendix 1	The per capita consumption of energy in the U.S.
Appendix 2	Nebraska's Energy Utilization 1976
Appendix 3	Nebraska's Energy Utilization 1970 to 1980.
Appendix 4	Grain Alcohol Plant Flow Diagram
Appendix 5	Fact Sheet on Gasohol
Appendix 6	Reading "Gasohol: Energy Mountain or Molehill?' by Earl V. Anderson C & EN July 31, 1978

A Fact Sheet on

GASOHOL

Introduction

Solar energy is often mentioned as a promising alternative to our energy problems. The problem, of course, is finding some convenient way to store this solar energy. Whether as a nation we realize it or not, the coal and oil we consume in such massive quantities is simply stored sunlight. The "storage" of this sunlight took place many millions of years ago when ancient sunlight, carbon dioxide and water was absorbed by equally ancient green plants to make then what we would now call fossil plants. These plants decayed to produce, over millions of years, coal and oil - stored vintage sunlight.

It seems inviting to think that it ought to be easy to urge our leafy brethern to simply make more coal and oil. Unfortunately, it simply isn't that easy. No one has discovered how to make chemical and physical reactions happen overnight which really took millions of years to happen naturally. In spite of this, our chlorophyll-containing friends do hold the promise of a solution to our supply of fossil fuels, which must certainly be finite in quantity.

The way in which green plants can provide us with energy does not involve new, unheard of technology, but may involve a word new to you - biomass. Simply stated, biomass refers to nature, harvested plants which have converted sunlight, carbon dioxide and water into organic carbon compounds. These plants may be burned as is (e.g. wood) to produce energy or new chemicals may be made from the plants. These "new" chemicals can then be burned as fuels. (1)

One of these "new" chemicals which can be obtained from plants is really old - almost older than man's recorded history. Egyptian and Mesopotamian artifacts show pictures of men fermenting grain to make alcoholic beverages at least 2500 B.C. (2) Besides its uses as a beverage, alcohols can be used as fuels, and this is the energy promise which plants hold for us. Let plants covert sunlight, carbon dioxide and water into plant sugars, ferment the sugars to make alcohol, and burn the alcohol as a fuel. The benefit, or course, is that the plants grow anew to replenish the burned up alcohol supply.

Could this scheme to replace our coal and gasoline burning devices with alcohol burners ever really work? Not only could it, it has! During World War I and II when gasoline was in short supply in Germany and France, many military tanks and planes carried "wood stills" on the vehicle, which heated or "distilled" wood. One of the products of distilling wood is an alcohol called methanol or wood alcohol, which was then burned to power the tanks and planes. In 1938 some 9,000 of these wood burning alcohol makers were being driven in Europe. Even in the U.S., as early as 1920, menthanol was produced as a fuel for airplanes. As of 1972, 1 billion gallons of methanol was produced, but virtually none was used as a fuel. In 1972 methanol was used as a solvent - paint thinner and in the production of plastics. (3) The reason alcohols aren't used as fuels today is simple to understand. Both methanol and ethanol are made from petroleum today, because petroleum is the cheapest way to make these alcohols. This may not always be the case.

Brazil is a good case in point. In 1977 Brazil was forced to import 80% of its oil, as opposed to 50% for the U.S. In Brazil the 1977 price of gasoline was $1.50 per gallon. The total cost to Brazil for its fuel in 1977 was 3 billion dollars. Brazil simply can't afford this. As a result, Brazil has committed $400 million since November of 1975 to gradually increasing ethyl alcohol production. The plan is to mix ethanol with gasoline so that by 1980 "gasoline" would be 20% ethanol and 80% gasoline in Brazil. The advantages to Brazil are obvious, but where will the ethanol come from? Plants to the rescue! In Brazil, the plan is to grow sugar cane or a starchy root plant called manioc. The sugar from the sugar cane and the starch from the manioc can both be fermented to make ethanol. Brazil is going to build alcohol plants to make their fuel! (4)

Will this alcohol-gasoline mixture really burn as well as gasoline, or is it just a desperation substitute? In Nebraska, starting in 1974, 45 vehicles were run for almost 3 years on gasoline-ethanol mixtures which were 10% ethanol and 90% unleaded gas. Altogether 2 million miles were covered in this experiment. The 10% - 90% mixture was and still is called gasohol. During this time, odometer readings and gallons of gasohol added were recorded at each refueling. Spark plugs were examined and compression measurements made periodically. The engine heads were removed from 10 vehicles, the valves and valve seats examined, and the cylinder diameters measured for wear. In addition, exhaust emissions were tested on some of the vehicles. (5) Here are some of the results: (6)

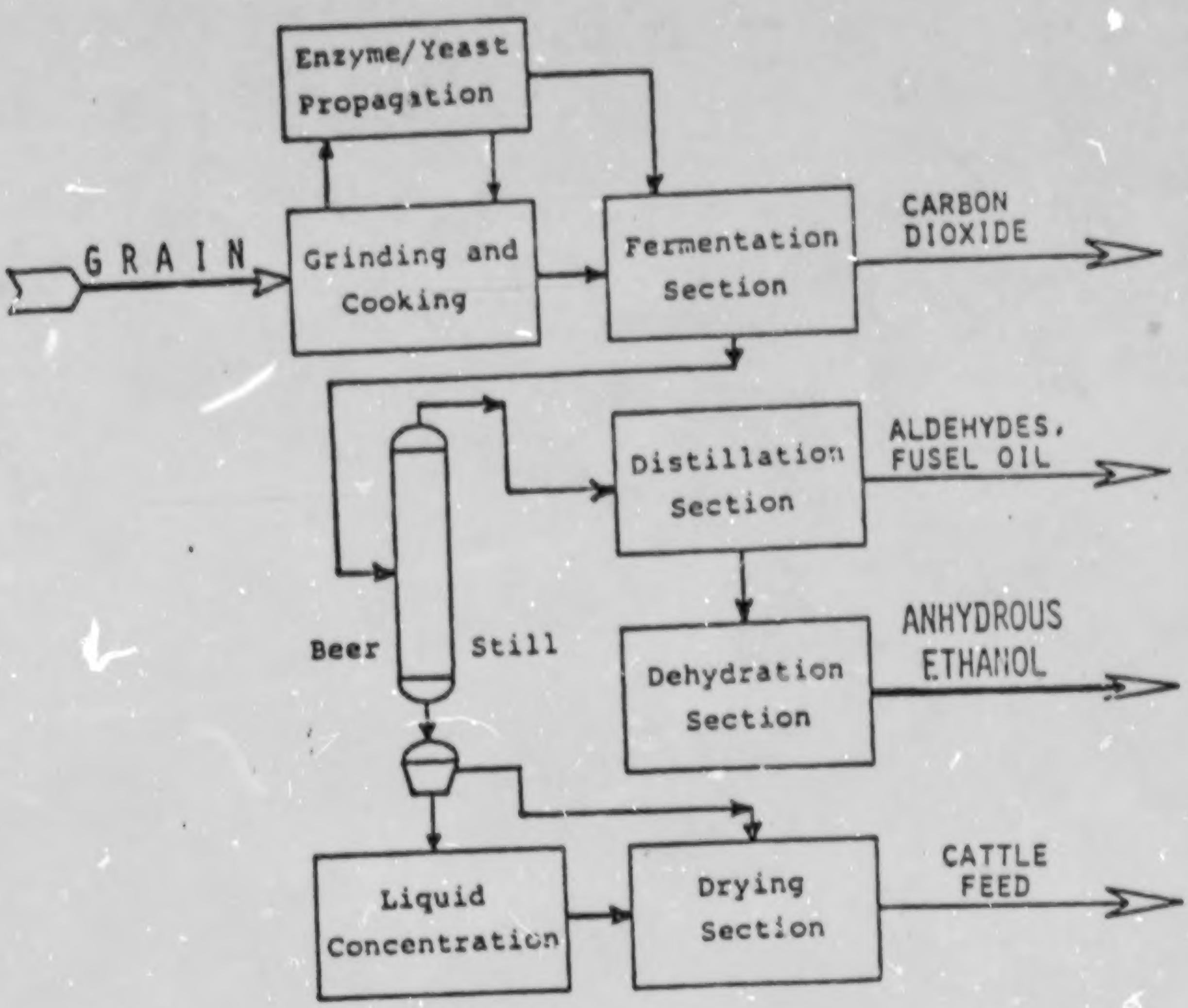
1. Gasohol can be burned in any internal combustion engine regardless of age without carburetor modification.
2. Gasohol has an octane rating 3 points higher than unleaded gasoline.
3. Exhaust emissions from gasohol contain one-third less carbon monoxide and one-tenth as many hydrocarbons as as the emissions from unleaded gasoline.
4. Gasohol causes no unusual engine wear.
5. Gasohol fueled vehicles consumed 5% less fuel than vehicles driven only on unleaded fuel.

It all sounds too good to be true doesn't it? A renewable fuel component which operates as good as or better than pure gasoline. Why don't we make it? Well, we can and we have in the U.S.A. For us, a logical choice would be to ferment grains such as corn, wheat or milo, which we grow in Nebraska and other midwestern states in surplus quantity. How would such a plant operate? A flow chart of a typical ethanol plant is shown in figure 1 of this packet. If you take a moment to look at it, you will discover a true serendipity. Besides the alcohol, fermentation of grain produces other saleable products including carbon dioxide to make dry ice or put the fizz in pop, and something called D.D.G. - distillers dried grain - which is the dry product left over after all the liquids from the fermentation are boiled off. This DDG is an excellent protein source and has been used as cattle feed with good results. Experiments to convert the DDG to a palatable human protein food are also being done. In a world with many mouth to feed, it "goes against the grain" of some people to use food to make fuel.

Fortunately, the fermentation of grains is able to provide both. The carbohydrate of the grain is converted to alcohol for fuel use and the protein of the grain is concentrated then dried into a solid protein food source.

Is it really possible to grow our fuel and eat it too? Right now the best answer seems to be a definite maybe. Dr. William Scheller, one of gasohol's leading advocates, sums it up nicely. "At least three factors are important to the economic future of gasohol. They are the price of gasoline, the price of grain, and the value of the DDG from the ethanol manufactrring process.." Scheller feels that the economics for gasohol production are favorable now. Other equally informed people feel that gasohol cannot be made today on a large scale and compete with gasoline. Whether or not we ever produce gasohol on a large scale will undoubtedly depend on whether our energy situation becomes more like Brazil's present condition.

FIGURE I


Enzyme/Yeast Propagation
GRAIN
Grinding and Cooking
Fermentation Section
CARBON DIOXIDE
Beer Still
Distillation Section
ALDEHYDES, FUSEL OIL
Dehydration Section
ANHYDROUS ETHANOL
Liquid Concentration
Drying Section
CATTLE FEED

GRAIN ALCOHOL PLANT
FLOW DIAGRAM

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   Factsheet by John and Kathryn Fowler

2. *The Production of Ethanol By Fermentation of Grain*
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3. *Methanol: A Versatile Fuel For Immediate Use*
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   Allen L. Hammond
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5. *Tests On Unleaded Gasoline Containing 10% Ethanol*
   Dr. William Scheller
   Dept. of Chemical Engineering - University of Nebraska

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   Agricultural Products Industrial Utilization Committee
   301 Centennial Mall South
   Lincoln, Nebraska

3.0

GASOHOL

Advantages of this energy alternative:

1. Gasohol when burned in the vehicle produces emissions containing less carbon monoxide, $CO_{(g)}$, and about equal amounts of nitrogen oxides, NO_x, and unburned hydrocarbons. The total emissions for Gasohol are somewhat less than for unleaded gasoline.

Component	Gasohol Gm/Mi	No-lead Gasoline Gm/Mi
CO	15.4	23.1
HC	1.8	2.0
NO_x	2.4	2.7
CO_2	751.9	768.9
Total	771.5	796.7

2. The distillers dried grain, a by-product of the fermentation of the grain in the production of the ethanol, contains all the protein that was originally present in the grain plus the additional protein from the yeast, resulting in a product containing 28% to 36% protein by weight. Animals feed on the distillers dried grains show a better weight gain than those fed on straight corn. The distillers dried grains contain protein which can be extracted for animal and human consumption.

3. Gasohol could reduce importing crude oil. Four billion gallons of grain alcohol converted to Gasohol would result in a 178 million barrels of crude oil saving each year.

4. The alcohol in Gasohol is produced from agricultural products which are renewable resources. Gasohol helps the farmer by providing a new market for his grains.

5. Gasohol has an average octane rating which is 3 numbers higher than the unleaded fuel from which it is produced.

6. Comparisons indicate there is a savings of at least 1.8 gallons of crude oil for each gallon of anhydrous grain alcohol used in producing Gasohol, or an overall net saving equivalent to 0.69 gallons of oil.

7. Ethanol produced by fermentation could be used to replace the 250 million gallons of ethanol produced synthetically from crude oil and naphtha via ethylene.

8. Gasohol fueled vehicles consume 5% less than those vehicles fueled with no-lead gasoline in the road tests. In other terms, 6,000 miles of driving expands to 7,000 miles when converted to Gasohol.

Advantages continued:

9. Sufficient amounts of grain and sugar are available in the United States to produce Gasohol without upsetting the food and feed markets.

10. Gasohol has a higher water tolerance than pure gasoline. Gasoline itself will hold only a few parts per million of water, whereas Gasohol will tolerate upwards of 0.25%. Gasohol will insure the driver of a completely dry fuel system in the vehicle.

11. It has been found in blending Gasohol that a positive volume change takes place. At 10% ethanol the mixture expands by about 0.23%.

12. Gasohol test vehicles indicated good starting in winter tests, and they have not experienced any vapor-lock problems during the summer tests.

13. Gasohol can be burned without carburetor modification. Engine inspections comparing Gasohol fuel with unleaded gasoline indicate no unusual wear or deterioration of the engine as a result of using Gasohol fuel.

14. Alcohol blended fuels such as Gasohol are commonly used in other countries - Brazil, Sweden, and West Germany recently moved to alcohol.

15. The grain used to produce Gasohol need not be the highest quality grain. Grain with an excessive moisture content, which is moldy, or even has started to sprout is suitable.

16. As petroleum becomes more and more scarce and expensive, the price gap between blends and straight gasoline will narrow. The sale of by-products, such as cattle feed made from grain residue after the distillation process, could make alcohol even more competitive. Unlike gasoline, the sources of alcohol are almost exhaustable.

17. The idea of growing crops for energy is not new. During the mid 19th century, wood accounted for over 90% of the U.S. energy supply. Stored chemical energy, created in vegetation by photosynthesis, may be a promising supplemental fuel in our energy future.

GASOHOL ADVANTAGES
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2. "The Production of Ethanol by the Fermentation of Grain" By Dr. Scheller Page 2
3. "Energy and Ethanol" by Dr. Wm. A. Scheller Page 10.
4. "Fact Sheet on Gasohol" by Agricultural Products Industrial Utilization Committee
5. "Energy and Ethanol" by Dr. Wm. A. Scheller Page 1.
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7. "Energy and Ethanol" by Dr. Wm. A. Scheller Page 2.
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11. Same as number 10 on page 2.
12. Same as number 10 on page 2.
13. Same as number 10 on page 2.
14. "Fact Sheet" by Agricultural Products Industrial Utilization Committee
15. "The Production of Ethanol by the Fermentation of Grain" by Dr. Wm. A. Scheller Page 2
16. U. S. News & World Report Jan. 6, 1978 Page 51.
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GASOHOL

Disadvantages of this energy alternative:

1. Ethanol costs about $1.25 per gallon compared to 38 cents per gallon for gasoline at the refinery gate.
2. A gallon of gasoline has about 135,000 Btu whereas a gallon of ethanol has only 85,000 Btu.
3. Since less expensive fossil fuels are available they should be used before the more costly gasohol.
4. Food grains should be used to feed the would's hungry rather than America's automobiles.
5. It would require 2.7 times more energy to produce ethanol than alcohol could deliver to the engine.
6. The large subsidies required for a gasohol program aren't justified by the small benefits that farmers would receive.
7. The high energy requirements of mechanized, high-yield farming makes it impractical to depend on agriculture to provide the energy needs of a technological society.
8. Gasohol is highly energy-inefficient and the cost of the product is much greater than the material it is replacing.
9. Assuming a nationwide gasohol program, there would be a sharp downward pressure on prices of both distillers dry grain and soybeans.
10. Collection of 75% of agricultural residue and using it for fuel is impractical.
11. For gasohol to be feasible corn would have to drop to $1 from $3 a bushel and ethylene climb to 15 cents a pound from its present 9 before they are competitive.

Gasohol Disadvantages

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1. Anderson, Earl V. *Chemical and Engineering News*. July 31, 1978, Page 8.
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6. Schinto, Jeanne. The Progressive, November 1977 Page 47.
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11. *Forbes*. September 15, 1975. Page 23

FERMENTATION OF GRAIN FOR ETHANOL RECOVERY

NOTE: This experiment is not recommended as a classroom experiment for each student, but should be done by the teacher as a demonstration.

INTRODUCTION

Relying on one of nature's oldest known chemical reactions, fermentation, ethanol can be procuced from replenishable grain sources rather than limited petroleum reserves. Ethanol produced from fermentation of grains might be used in the suggested gasohol program.

Before grain can be fermented it is first necessary to convert grain starch into sugar. This is done by germinating the seeds. During germination enzymes, found beneath the seed coat, convert the stored starch into sugar.

Having obtained a supply of sugar the fermentation process can begin. Yeast is added to the mixture. The yeast converts the sugar present into alcohol. When the alcohol content reaches 15% the yeast are killed, thus ending the production of alcohol.

In fermentation the following reaction occurs:

1. $\text{Starch} \longrightarrow \text{Sugar} \longrightarrow \text{Ethanol} + \begin{matrix}\text{carbon}\\ \text{dioxide}\end{matrix}$

2. $(C_6H_{10}0_5)_n \xrightarrow[\text{enzymes}]{\text{germination}} C_6H_{12}0_6 \xrightarrow[\text{enzymes}]{\text{fermentation}} 2C_2H_5OH + 2CO_2$

This lab is designed to show that grain can be used to demonstrate fermentation and produce ethanol.

Teacher Demonstration

MATERIALS

1 500 ml flask
1 rubber stopper (1 Hole)
glass tubing
1 ring stand
1 test tube clamp
1 rubber hose
1 100 ml graduated cylinder
1 500 ml beaker

400 ml distilled water
100 g grain (corn or milo)
1 g soldium hydrogen phosphate (Na_2HPO_4)
Lime Water
1/4 package dry yeast

PROCEDURE

Note: There have been a number of problems reported using this procedure. The teacher should plan to research and modify the procedure as needed.

1. Germination of Grain

   a. This is done by adding 200 ml distilled water to the 100 g of grain in the 500 ml flask.

   b. Place the culture in a warm (90-100°F) location for 3-4 days.

2. Fermentation of Grain

   a. After germination has occurred add an additional 150 ml distilled water to the flask and bring this mixture to a boil for 15 minutes.

      This heating is done to kill unwanted bacteria.

   b. Let the mixture cool to less than 100°F. It is VERY IMPORTANT that the mixture is not warmer than this.

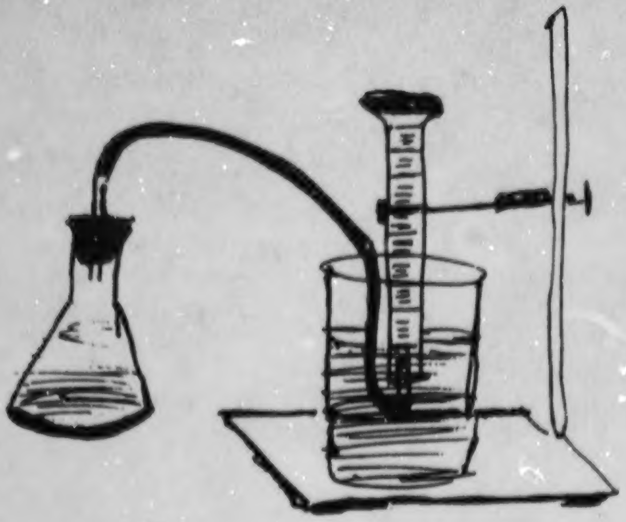
   c. To the cooled mixture, add 1g Na_2HPO_4

   d. Dissolve 1/4 package of yeast in 50 ml of warm water; add this mixture to the flask.

   e. Place the rubber stopper in the flask and set up the apparatus (see diagram) to measure gas (CO_2) production.

   f. Record the volume of gas present in the graduated cylinder every other day until there is no longer an increase in the gas volume or until volume becomes too great to measure.

   g. Record the temperature of the room and barometric pressure on the final day of recording of gas volume.



The graduated cylinder should be immersed as far as possible in the beaker. containing lime water.

The volume of air that remains should be recorded.

AN ALTERNATIVE FERMENTATION PROCEDURE

MATERIALS (per class of 30)

350	ml corn syrup
3	Liters of distilled water
1/2	package dry yeast
1	gallon bottle
1	balloon

PROCEDURE

Mix the corn syrup and water in a gallon bottle

Add dissolved yeast

Place balloon on top of bottle and let sit for 3-5 days.

Observe expanding of balloon. When fermentation is no longer occurring the balloon will decrease in size.

THE DISTILLATION OF THE LIQUID FROM GRAIN FERMENTATION

I. Introduction

The boiling point of a pure liquid is an excellent characteristic property useful for isolating a component of a solution. This is no exception for the liquid produced by fermentation. The ethanol can be separated by distillation. This is complicated only by the fact that 100 percent absolute alcohol doesn't distill from a fermentation solution. An azeotrope forms which distills at 78.2°C, instead of 78.5°C for 100 percent ethanol Since the ethanol - water azeotrope remains constant in composition, no amount of distilling produces 100 percent pure ethanol, rather a 95 percent ethanol - 5 percent water mix distills continuously at 78.2°C.

The purpose of this experiment is to determine the percent composition of the fermentation liquid and to make a qualitative test for the presence of an alcohol.

II. The Experiment

A. Materials for the distillation.

1. 30 - 50 cc of filtered fermentation liquid.
2. The glassware for the distillation may be as sophisticated as bonafide distillation flasks with water jacket condensers or as simple as flat bottom flasks with stoppers and air cooled glass bends.
3. Although bunsen burners are an adequate heat source, hot plates reduce the chance of alcohol fires.
4. Containers to receive fractions collected.

5. Student grade celsius thermometer with 1° increments.
6. Ring stand(s) and clamp(s) as needed.

B. Procedure

Heating should take place at a rate to produce 1 to 2 cc of distillate per minute. Care should be taken as heating to dryness approaches. Any solids dissolved in the fermentation liquid which are organic (e.g. sugar) may decompose if heated too strongly. This complicates clean up. The teacher should instruct students at which temperatures to collect fractions.

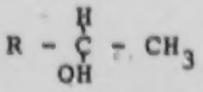
C. Data

The minimum data required to determine the percent composition of the fermentation liquid are:

1. The mass of the distillation flask and fermentation liquid.
2. The mass of the distillation flask.
3. The mass of each distillate receiver and distillate.
4. The mass of each distillate receiver.

D. Test for Ethanol

Secondary alcohols of the type



$R - \overset{H}{\underset{OH}{C}} - CH_3$

react with alkaline iodine solutions to produce iodoform, CHI_3, which is a yellow crystaline solid at room temperature. The procedure for the test and the reaction forming iodoform are given below:

Comparison of the fermentation distillate with pure ethanol is recommended. To 5cc of distillate, add 2cc of 10 percent soldium hydroxide solution. Next add drop by drop a solution of sodium iodine and iodine (Lugol's solution) to the distillate until a slight iodine color remains.

Warm the distillate to 50°C for 15 minutes, then cool. Yellow CHI_3 crystals should form. (These CHI_3 crystals explode at 210°C). Besides this chemical test, the boiling point and a density determination are also possible. The difference between the density of absolute ethanol and 95 percent ethanol is too close to measure reliably with centigram equipment.

$CH_3\ CH_2(OH) + 4I_2 + 6Na(OH)\ \text{--}\ Na(HCOO) + 5NaI + 5H_2O + CHI_3$

E. Safety

Lugol's solution represents a hazard because of the iodine. It would be wise to have a sodium thiosulfate solution handy to convert any spilled I_2 to I^-.

III. Calculations and Questions

1. Calculate the percent composition for the fermentation liquid.
2. Natural fermentation can produce only about 15 percent ethanol solution. Why?
3. A typical 90 proof hard liquor is about 45 percent alcohol. How can such a beverage be made if natural fermentation can only produce a 15 percent alcohol solution?
4. If distillation of a fermented product can produce only 95 percent ethanol, how is 100 percent ethanol made?
5. Besides overindulgence, what is a very real hazard of drinking any home-made alcoholic beverage.
6. Give as many pieces of evidence as you can to prove that the bulk of the liquid you distilled at

78°C was ethanol.

7. Time permitting, make a graph of temperature vs. time for this experiment.

Experiment

Heat of Combustion of Ethyl Alcohol

$CH_3CH_2OH_{(l)}$

Part I Introduction

Energy shortages and high prices have created a growing interest in ethanol, $CH_3CH_2OH_{(l)}$, as a motor fuel. In 1876 Nikolaus Otto invented the four-cycle engine to run on ethanol. Some of Henry Ford's first automobiles ran on alcohol and most racing cars run on alcohol today. In the 1920s methanol, $CH_3OH_{(l)}$, was used for fuel injection in piston aircraft. During the Great Depression of the 1930s, service stations in the Mid-West sold Agrol, a gasoline and grain-derived ethanol blend. During W. W. II, American troops fought against Germany's alcohol-propelled war machine. Brazil, Sweden, and West Germany have recently moved toward a total switch from gasoline to alcohol. All cars in Brazil now run on from 2% to 10% alcohol.

"Gasohol" became an officially registered tradename in the State of Nebraska in Nov. of 1974. Gasohol is a fuel consisting of a blend of 10% agriculturally derived ethyl alcohol, $CH_3CH_2OH_{(l)}$, and 90% unleaded gasoline. The ethyl alcohol can be made from any grain like wheat, corn, milo, potatoes, and sugar beets by the following reaction:

Fermentation Reaction

$$\underset{\text{starch in grain}}{C_6H_{10}O_5} + H_2O \xrightarrow{\text{enzyme}} \underset{\text{sugar glucose}}{C_6H_{12}O_6} \xrightarrow{\text{yeast}} \underset{\text{ethyl alcohol}}{2CH_3CH_2OH_{(l)}} + 2CO_{2(g)}$$

The grains used represent a renewable source of energy that can be grown every year, utilizing cheap solar energy from the sun. The yield of ethyl alcohol from the grain is approximately 2.5 gallons per bushel when it is extracted from corn.

In this experiment you will be investigation the complete combustion (burning) of ethyl alcohol, $CH_3CH_2OH_{(l)}$, the 10% component of Gasohol.

Introduction continued:

The following equation shows the complete comustion (burning) of ethyl alcohol:

$CH_3CH_2OH_{(l)} + 3\ O_2(g) \dashrightarrow 2\ CO_{2(g)} + 3\ H_2O_{(g)} + \underline{???}Heat$

The problem in this experiment is to determine the heat (in Kcal and BTU) produced by the burning of ethyl alcohol.

Heat is a form of energy. The three units most commonly used in measuring the quantity of heat are:

(a) 1 calorie (cal) = the heat required to raise the temperature of 1 gram of water 1°C.

(b) 1 Kilocalorie (Kcal) = 1000 calories, or the heat required to raise the temperature of 1 liter of water 1 °C.

(c) 1 British Thermal Unit (BTU) = the heat to raise the temp. of 1 lb of water 1 °F.

Since 1 lb. = 453.6 grams and 1°F = 5/9 °C

THEN

1 BTU = 453.6 x 5/9 cal = 252 calories

OR

1 BTU = 0.252 Kcal

In this experiment you will measure the heat lost by the complete combustion (burning) of ethyl alcohol, the 10 percent component of Gasohol, by determining the heat gained by a container of water held above the burning ethyl alcohol. The heat gained by the water can be calculated using the following equation:

Heat gained by = mass x specific heat x temp. change a body (cal)

Part II EXPERIMENT

A. Materials required in the experiment to determine the heat of combustion of ethyl alcohol:

1. denatured ethyl alcohol, $CH_3CH_2OH_{(l)}$
2. glass alcohol burner
3. ring stand and ring clamp
4. soup can with 2 holes punched in the sides of the open end
5. balance
6. thermometer °C

Experiment continued:

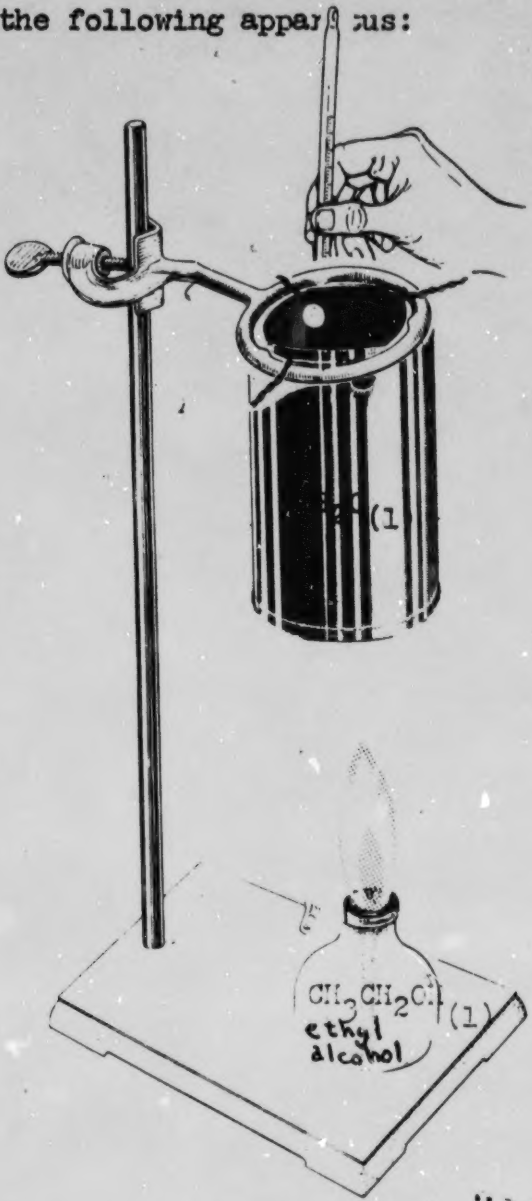
B. Procedure

1. Fill the glass alcohol burner with the ethyl alcohol, $CH_3CH_2OH_{(l)}$, and weigh the filled burner on the balance and record the mass in the Data Table.

2. Weigh the empty can on the balance and record the mass in the Data Table.

3. Fill the weighed can about two-thirds full with cold tap water. Cool the water with ice, if necessary, so that its temperature is about 10 to 15 °C below room temp. Add the ice directly to the water. Remove any remaining ice when the desired temp. has been reached.

4. Set up the following apparatus:



Apparatus

Experiment continued:

5. Read and record the temperature of the water in the can, and record it in the Data Table.

6. Light the alcohol burner and adjust the can so the bottom is in the hottest part of the flame. Continue heating the water, stirring it gently, until it reaches a temperature about as much above room temperature as it was below at the start. The following reaction shows the complete comustion (burning) of the ethyl alcohol:

$$CH_3CH_2OH_{(l)} + 3\ O_{2(g)} \dashrightarrow 2\ CO_{2(g)} + 3\ H_2O_{(g)} + \text{Heat}$$

The heat produced by the burning ethyl alcohol is absorbed by the water in the can.

7. Blow out the alcohol burner, continue to stir the water, while watching the thermometer reading, until the highest temperature is reached. Record this temperature in the Data Table.

8. Next weight the alcohol burner on the same balance that was used to weight it at the start. Record the mass in the Data Table.

9. Weight the can and water on the balance and record the weight in the Data Table.

10. Clean up and return the materials, then complete the Data Table.

Data Table

---

1. Weight of the alcohol burner at the start of the experiment............................______grams
2. Weight of the alcohol burner at the end of the experiment..............................______grams
3. Weight of the ethyl alcohol, $CH_3CH_2OH_{(l)}$ burned during the experiment.........................______grams
4. Weight of the empty can............................______grams
5. Weight of the can plus the heated water............______grams
6. Weight of just the water in the can which absorbed the heat from the burning ethyl alcohol............______grams
7. Temperature of the water in the can at the start of the experiment............................______°C
8. Temperature of the water in the can at the end of the experiment..............................______°C
9. Change in the temperature of the water............______°C

$\Delta t =$ ______°C

Part III Calculations and Problems

1. Calculate the quantity of heat (calories) released by the burning ethyl alcohol to warm the water in the can. Assume that all of the heat from the burning alcohol was used in heating only the water.

   HINT: Heat gained = mass x specific heat x temp. change

   specific heat = water

   ________calories of heat absorbed by the water in the can

2. Calculate the number of moles of ethyl alcohol burned in the experiment.

   ________moles of CH_3CH_2OH burned.

3. Calculate the number of kilocalories of heat (Heat of Combustion) produced by burning one mole of ethyl alcohol according to your experimental data.

   ________Kcal/mole

   Convert this to BTu/mole

   ________Btu/mole

4. The Handbook of Physics and Chemistry lists the Heat of Combustion of ethyl alcohol as:

   Heat of Combustion of CH_3CH_2OH ethyl alcohol = 327.6 Kcal/mole

   Convert this to BTu/mole and Btu/gallon

   ________Btu/mole ________Btu/gallon

5. How does your experimental value for the Heat of Combustion for ethyl alcohol (Question 3) compare with the "Handbook" value? Higher or Lower: ____________ Explain the reason they differ: ____

   ____

6. The following reaction shows the complete combustion of wood alcohol, $CH_3OH_{(l)}$. Balance the equation:

   $$\underline{\quad}CH_3OH_{(l)} + \underline{\quad}O_{2(g)} \longrightarrow \underline{\quad}CO_{2(g)} + \underline{\quad}H_2O_{(l)} + \text{Heat}$$

   A student found by burning 1 gram of methyl alcohol he produced 10.69 Kcal of heat. Calculate the Heat of Combustion (Kcal/mole) for methyl alcohol using this date.

   Heat of Combustion $CH_3OH_{(L)}$ = ____________Kcal/mole

Problems continued:

Answer to question 6 is 171 Kcal/mole

Independent Study Experiment:

Repeat this experiment and determine the Heat of Combustion of methyl alcohol, $CH_3OH_{(l)}$ wood alcohol, in place of the ethyl alcohol.

Additional Problems

1. How many calories are required to heat each of the following 15°C to 65 °C:

   (a). 100 grams of water (answer 5,000 calories or 5 Kilocalories)

   (b). 5 grams of pyrex glass (Hint: specific heat of pyrex glass = 0.20)
   (answer 50 calories)

   (c). 20 grams of platinum (Hint: specific heat of platinum = 0.032)
   (answer 32 calories)

2. How many Btu are removed in cooling each of the following from 212°F to 68°F:

   (a). 1 lb of water (answer = 144 Btu)

   (b). 2 lb of leather (Hint: specific heat of leather = 0.36)
   (answer = 104 Btu)

   (c). 3 lb of asbestos (Hint: specific heat of asbestos = 0.20)
   (answer = 86 Btu)

3. The combustion of 5.0 grams of coal raised the temp. of one liter of water from 10 °C to 47 °C. Calculate the Heat of combustion of coal in Kcal/gram.
   (answer = 7.4 Kcal/gram)

4. Fuel oil has a Heat of Combustion of 19,000 Btu/lb. Assuming that 70% of the heat is aborbed and 30% is lost, how many pounds of oil are required to heat 1000 lb of water from 50 °F to 190 °F? (answer = 10.5 lb)

Additional Problems:

5. (a) Show the balanced reaction for the complete combustion of ethane gas, C_2H_6:

$\longrightarrow$ ______________________________

answer: ___ C_2H_6 + 1/2 $O_{2(g)}$ ---> $2CO_{2(g)}$ + 3 $H_2O_{(g)}$ + Heat

(b) Burning 5 grams of ethane produced 62.17 Kcal of heat. Calculate the Heat of Combustion of ethane:

____________Kcal/mole

(answer = 373 Kcal/mole)

(c) Assuming that 60 percent of the heat is absorbed and 40 percent lost, calculate how many liters of ethane at S.T.P. must be burned to supply enought heat to raise the temperature of 50 kilograms of water at 10°C to steam at 100°C.

__________liters (answer = 3150 liters of ethane)

6. (a) Show the balanced equation for the complete combustion of natural gas, $CH_{4(g)}$:

$\longrightarrow$ ______________________________

(answer: 1 $CH_{4(g)}$ + 2 $O_{2(g)}$ ----> 1 $CO_{2(g)}$ + 2 $H_2O_{(g)}$ + heat)

(b) Burning 4 grams of natural gas produced 53.25 Kcal of heat. Calculate the Heat of Combustion of natural gas. _________Kcal/mole (answer: 213 Kcal/mole)

(c) Assuming that 50 percent of the heat is absorbed and 50 percent lost, how many kilograms of water at 15°C could be heated to 95°C by burning 200 liters of natural gas, $CH_{4(g)}$, at S.T.P.?

___________kilograms of water

(answer = 11.9 kilograms)

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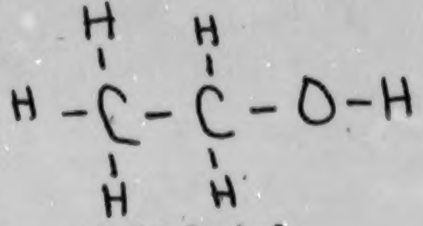
Gasohol Worksheet

Sample Problem List

1. Gasohol is a blend of 10% agriculurally derived 200 proof anhydrous ethyl alcohol and 90% unleaded gasoline. Ethyl alcohol (ethanol) is an organic compound with the following empirical formula, C_2H_6O. The structural formula for ethyl alcohol is shown below:



$$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-O-H$$

ethyl alcohol

List the structural formula for a structural isomer of ethyl alcohol:

____

isomer

2. The complete combustion of natural gas, $CH_{4(g)}$, is shown in the following reation:

$$CH_{4(g)} + 2\,O_{2(g)} \longrightarrow CO_{2(g)} + 2\,H_2O_{(g)} + \text{energy}$$

Gasohol is a blend of 10% ethyl alcohol, $CH_3CH_2OH_{(l)}$, and 90% unleaded gasoline, $C_8H_{18(l)}$.

(a) Show the balanced equation for the complete combustion of ethyl alcohol, the 10% component of Gasohol:

$$\longrightarrow$$

____

(b) Show the balanced equation for the complete combustion of octane, C_8H_{18}: $\longrightarrow$

____

3. Gasohol is a blend of 10% ethyl alcohol, $CH_3CH_2OH_{(l)}$, produced from the fermentation of grains. Answer the following questions for ethyl alcohol:

(a) Is it an organic or inorganic compound? ________________

(b) What is the mass of one mole of ethyl alcohol? ____________ g/mole

(c) Calculate the volume of one mole of ethyl alcohol.in ml. Density of ethyl alcohol = 0.789 grams/ml

________________ ml/mole

(d) Calculate the % by weight of carbon in ethyl alcohol.

________________ % by wt. of carbon

4. A bushel of corn can be converted to 2.5 gallons of ethyl alcohol in a Gasohol plant by the following reaction: (glycolysis) 1 gallon = 3,785 ml

$$\underset{\text{starch in grain}}{C_6H_{10}O_5} + H_2O \xrightarrow{\text{enzyme}} \underset{\text{sugar glucose}}{C_6H_{12}O_6} \xrightarrow{\text{yeast}} \underset{\text{ethyl alcohol}}{2CH_3CH_2OH_{(l)}} + 2\,CO_{2(g)}$$

Calculate the number of moles of glucose that would be needed to produce 2.5 gallons of ethyl alcohol.

_______________moles of ethyl alcohol

5. Write the balanced equation for the production of glucose by photosynthesis:

$$\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \longrightarrow \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Calculate the number of liters of water required to produce the sugar (glucose) needed to produce 2.5 gallons of ethyl alcohol.

_____________liters of H_2O

6. The total amount of solar energy required in the production of a bushel of corn is approximately 1×10^9 Btu. The recoverable energy from the 2.5 gallons of ethyl alcohol produced by a bushel of corn is about 2.7×10^4 Btu. What is the efficiency in this conversion?

_______________%

7. The complete combustion of octane, $C_8H_{18(l)}$, a component of gasoline is shown below. Balance the equation:

$$\_\_\,C_8H_{18(l)} + \_\_\,O_{2(g)} \longrightarrow \_\_\,CO_{2(g)} + \_\_\,H_2O_{(g)} + \text{energy}$$

The density of octane = 0.7036 grams/ml
one gallon = 3.7853 liters

Using the above information calculate the number of liters of oxygen required for the complete combustion of one gallon of octane at S.T.P.

_________liters of $O_{2(g)}$

8. The complete combustion of ethyl alcohol, 10% component of Gasohol, is shown in the following reaction. Balance the equation:

$$\_\_CH_3CH_2OH_{(l)} + \_\_\,O_{2(g)} \longrightarrow \_\_CO_{2(g)} + \_\_H_2O_{(g)} + \text{energy}$$

The density of ethyl alcohol = 0.789 grams/ml
one gallon = 3.7853 liters

Using the above information calculate the number of liters of oxygen required for the complete combustion of one gallon of ethyl alcohol at S.T.P.

______________ liters of $O_{2(g)}$

9. Below is a table of exhaust gases from two test vehicles obtained by the ERDA Energy Research Center comparing Gasohol and unleaded gasoline:

Data Table

Component in exhaust	Gasohol grams/mile	No-lead Gasoline grams/mile
1. carbon monoxide $CO_{(g)}$	15.4	23.1
2. unburned hydrocarbons HC	1.8	2.0
3. nitrogen oxides NO_x	2.4	2.7
4. carbon dioxide $CO_{2(g)}$	751.9	768.9

Assuming a fuel consumption of 15 miles/gallon for this problem:

(a) Calculate the number of grams of carbon monoxide added to the atmosphere by burning one gallon of Gasohol.

____________ grams of $CO_{(g)}$

(b) Calculate the number of grams of carbon monoxide added to the atmosphere by burning one gallon of No-lead gasoline.

____________ grams of $CO_{(g)}$

(c) How can you explain the lower carbon monoxide concentrations in the exhaust using Gasohol?

____

____

10. There are two methods used in the production of ethyl alcohol, CH_3CH_2OH. Method 1 is by fermentation of carbohydrates, which is used (1) to make the ethyl alcohol in Gasohol production:

Method 1

$$C_6H_{10}O_5 + H_2O \xrightarrow{\text{enzyme}} C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2CH_3CH_2OH_{(l)} + 2\ CO_2(g)$$

starch in grain — sugar glucose — ethyl alcohol

Method 2 is by hydration of alkenes obtained from the cracking of crude oil:

Method 2

$$CH_2{=}CH_2 + H_2SO_4 \longrightarrow CH_3{-}CH_2{-}OSO_3H \xrightarrow{H_2O} CH_3CH_2OH_{(l)} + H_2SO_4$$

ethylene crude oil — sulfuric acid — ethyl alcohol

At the present time most of the synthetic ethyl alcohol produced in this country (250 million gallons a year) is done using Method 2. If you started with one kilogram of ethylene and recovered 689.92 grams of ethyl alcohol, what would be your percent yield? Assume an excess of all other reagents.

_______________% yield

11. A chemical component of gasoline is 2,2,4-trimethyl pentane. Using a set of ball and stick models, buildi~~ng~~ a molecule of this compound.

12. The chemical name for grain alcohol is ethanol, which is ethane with an -OH group substituted for an -H. Using a set of ball and stick models, build a molecule of ethanol.

13. The density of gasoline is 0.692 grams/cc. How many grams of gasoline are there in one gallon of gasoline? (Hint: one gallon contains 3.785 cc)

_________________ grams

14. The density of pure ethanol, $CH_3CH_2OH_{(l)}$, is 0.789 gm/cc. How many grams of ethanol are there in one gallon of ethanol? (Hint: one gallon contains 3.785 cc)

_________________ grams

15. When gasoline burns completely, the following equation describes what happens. Balance the equation:

$$\_\_C_8H_{18(l)} + \_\_O_{2(g)} \longrightarrow \_\_\_CO_{2(g)} + \_\_H_2O_{(g)} + \text{energy}$$

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16. When pure ethanol burns completely, the following equation describes what happens. Balance the equation including heat heat as a product:

___$C_2H_5OH_{(g)}$ + ___ $O_{2(g)}$ ——— $\rightarrow$ $CO_{2(g)}$ + ___$H_2O_{(g)}$ + ________

17. Use the balanced equation for the complete combustion of octane along with the heat of formation values listed below to calculate how many Kilocalories of energy are contained in one gallon of gasoline, C_8H_{18}. Hint: First calculate the Heat of Combustion using the H_f values.

H_f $C_8H_{18(g)}$ = - 51.97 Kcal/mole

H_f $CO_{2(g)}$ = - 94.05 Kcal/mole

H_f $H_2O_{(g)}$ = - 57.80 Kcal/mole

____________Kcal/mole octane, C_8H_{18}

____________Kcal/gallon

18. Use the balanced equation for the complete combustion of ethanol along with the heat of formation values listed below to calculate how many Calories of energy are contained in one gallon of pure ethanol, C_2H_5OH.

H_f $C_2H_5OH_{(g)}$ = - 56.24 Kcal/mole

H_f $CO_{2(g)}$ = - 94.05 Kcal/mole

H_f $H_2O_{(g)}$ = - 57.80 Kcal/mole

____________Kcal/mole ethyl alcohol C_2H_5OH

____________Kcal/gallon

19. Gasohol is a mixture of pure ethanol, C_2H_5OH, and unleaded gasoline. Here is how the Gasohol is mixed:

0.900 of a gallon of unleaded gasoline is mixed with

0.100 of a gallon of pure alcohol

The result is suprising. The volume increases ever so slightly to 1.002 gallons! Using the energy values of 110,400 Btu per gallon for the burning of gasoline and 78,600 Btu per gallon for the burning of pure ethanol, calculate the energy obtained from burning one gallon of Gasohol.

________________Btu/gallon of Gasohol

20. Wood can be heated in a tube with limited oxygen supply so that the wood "distills" rather than burns. That is, the cellulose in the wood breaks up into simpler molecules. One of these "simpler" molecules is methanol, which may be used as a gasoline additive or substitute. During World War II, many Europeans drove "wood burning" cars, because gasoline was in short supply. These vehicles had small wood "stills" mounted on them which produced some methanol, CH_3OH, by distillation which was then burned. This was not a good system, but it worked in a pinch.

(a) If you assume that the formula for wood is $C_{32}H_{46}O_{23}$, and that 40% of the wood is converted to methanol by heating. How many kilograms of methanol can be obtained from 1.00 kilogram of wood?

______________ kilograms of methanol

(b) If this methanol is burned according to the following reaction, balance the equation:

$$\_\_ CH_3OH_{(l)} \quad \_\_ O_{2(g)} \longrightarrow \_\_ CO_{2(g)} + \_\_ H_2O_{(g)} + \text{heat}$$

If you were to burn all of the wood alcohol produced in Part (a), how much heat is produced. The ΔH for the above reaction is: -170.19 Kcal/mole.

____________ Kcal

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Solutions for the Gasohol Worksheet

for the Instructor

1. Structural isomer for C_2H_6O: CH_3-O-CH_3

2. (a)

$\underline{\ 1\ }\ CH_3CH_2OH_{(l)} + \underline{\ 3\ }\ O_{2(g)} \longrightarrow \underline{\ 2\ }\ CO_{2(g)}\ \ \underline{\ 3\ }\ H_2O_{(g)}$ + energy

(b)

$\underline{\ 1\ }\ C_8H_{18(l)} + \underline{\ 12.5\ }\ O_{2(g)} \longrightarrow \underline{\ 8\ }\ O_{2(g)} + \underline{\ 9\ }\ H_2O_{(g)}$ = energy

3. (a) Organic - carbon chain containing compound

(b) $CH_3CH_2)HO$ carbon 2 x 12 grams = 24 grams

hydrogen 6 x 1 grams = 6 grams

oxygen 1 x 16 grams = 16 grams

total 46 grams/mole

(c) $46\ \text{grams/mole} \times \dfrac{1\ \text{ml}}{0.789\ \text{gram}} = 58.30\ \text{ml/mole}$

(d)

$$\frac{\text{Number of carbon atoms} \times \text{atomic wt. of carbon}}{\text{formula wt. of ethyl alcohol, } CH_3CH_2OH} \times 100 = \underline{\quad}\%\ \text{by wt. of carbon}$$

$$\frac{2\ \text{atoms} \times 12.0\ \text{grams}}{46} \times 100 = 52.2\%\ \text{carbon by wt.}$$

4. $2.5\ \text{gallon} \times 3.78\ \dfrac{\text{liters}}{\text{gallon}} \times 1000\ \dfrac{\text{ml}}{\text{liter}} \times 0.789\ \dfrac{\text{g}}{\text{ml}} \times \dfrac{1\ \text{mole}}{46\ \text{grams}} =$

162.09 moles CH_3CH_2OH

1 mole glucose ($C_6H_{12}O_6$) produces 2 moles of ethanol (CH_3CH_2OH)

thus $\dfrac{162.09\ \text{moles}}{2} = 81.05$ moles of glucose, $C_6H_{12}O_6$

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Gasohol

Worksheet

Solutions

5. $6CO_2 + 6H_2O \xrightarrow{\text{Light}} \underset{\text{glucose}}{C_6H_{12}O_6} + 6O_{2(g)}$

to make 81.05 moles of glucose requires 6 x 81.05 = 486.3 moles H_2O

$$486.3 \text{ moles } H_2O \times \frac{18g}{\text{mole}} \times 1 \frac{\text{ml}}{\text{gm}} \times \frac{1 \text{ liter}}{1000 \text{ ml}} = 8.75 \text{ liter } H_2O$$

6. $\frac{2.7 \times 10^4 \text{ Btu}}{1 \times 10^9 \text{ Btu}} \times 100 = 2.7 \times 10^3$ or 0.0027

7 Step 1 Calculate the number of grams of octane in one gallon:

$$1 \text{ gal} \times 3.7853 \frac{L}{\text{gal}} \times \frac{1000 \text{ ml}}{L} \times 0.7036 \frac{g}{m} = 2663.34 \frac{\text{grams}}{\text{gal}}$$

Step 2 Calculate the number of moles of octane:

$$2663.34 \frac{g}{\text{gal}} \times \frac{1 \text{ mole}}{114.23 \text{ g}} = 23.316 \frac{\text{moles}}{\text{gal}}$$

Step 3 Using the balanced equation calculate the number of moles of oxygen required:

$$23.316 \text{ moles octane} \times 12.5 \frac{\text{mole oxygen}}{\text{mole octane}} = 291.45 \text{ moles oxygen}$$

Step 4 Convert moles of oxygen to liters:

$$291.45 \text{ moles oxygen} \times 22.4 \frac{\text{liters}}{\text{mole}} = 6528.48 \text{ liters of oxygen}$$

8. Step 1 Calculate the number of moles of ethyl alcohol in one gallon:

$$1 \text{ gallon} \times 3.7853 \frac{\text{liters}}{\text{gal}} \times 1000 \frac{\text{ml}}{L} \times 0.789 \frac{g}{\text{ml}} \times \frac{1 \text{ mole}}{46.07 \text{ g}} = 64.83 \frac{\text{moles}}{\text{gal}}$$

Step 2 Using the balanced equation calculate the volume of oxygen required:

$$64.83 \text{ moles ethyl alcohol} \times 3 \frac{\text{moles oxygen}}{\text{moles ethyl alcohol}} \times 22.4 \frac{\text{liters}}{\text{mole oxygen}} = 4356.8 \text{ liters oxygen at S.T.P.}$$

Gasohol

Worksheet

Solutions

9. (a) $$15\ \frac{\text{miles}}{\text{gal}} \times 15.4\ \frac{\text{grams}}{\text{mile}} = \frac{\text{grams CO}}{\text{gal of Gasohol}}$$

(b) $$15\ \frac{\text{miles}}{\text{gal}} \times 23.1\ \frac{\text{grams}}{\text{mile}} = 346.5\ \frac{\text{grams CO}}{\text{gal of No-Lead gasoline}}$$

(c) The additional CO produced by the No-Lead gasoline can be explained using the balanced equations for complete combustion:

ethyl alcohol = $CH_3CH_2OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ + energy

gasoline = $C_8H_{18} + 12.5O_2 \longrightarrow 8CO_2 + 9H_2O$ + energy

It requires more oxygen for the complete combustion of gasoline.

10. Step 1 Calculate the number of moles in 1 kilogram of ethylene.

$$1000\ \frac{\text{gram}}{\text{kilogram}} \times 1\ \frac{\text{moles}}{\text{grams}} = 35.71\ \underline{\text{moles}}$$

Step 2 Calculate the theoretical yield of ethyl alcohol using the balanced equation:

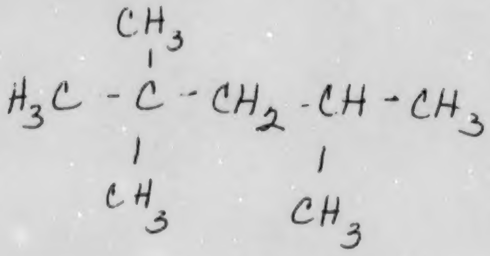
35.71 moles of ethylene could prodice 35.71 moles of alcohol. Convert this to grams:

$$35.71\ \text{moles} \times 46\ \frac{\text{grams}}{\text{mole}} = 1642.66\ \text{grams}$$ 100% yield ethyl alcohol

Step 3 $$\%\ \text{yield} = \frac{\text{Exp. yield}}{\text{theoretical yield}} \times 100$$

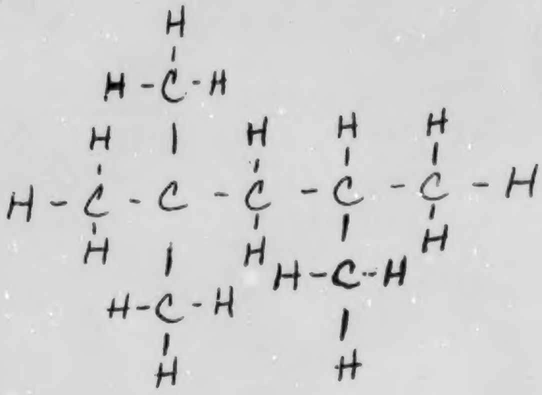
$$\frac{689.92\ \text{grams}}{1642.66\ \text{grams}} \times 100 = 42\%$$

11. 2, 2, 4, - trimethyl pentane



$$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-CH_2-\underset{CH_3}{CH}-CH_3$$

(OR)



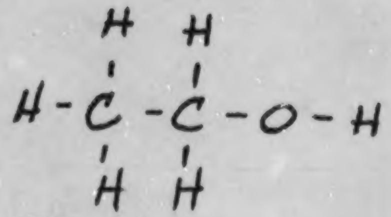
Gasohol

Worksheet

Solutions

12. Ethanol

(ethyl alcohol) CH_3-CH_2-OH OR



$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-O-H$

13. $0.692.\ \frac{gm}{cc} \times 3{,}785\ \frac{cc}{gal} = 2.62 \times 10^3\ \frac{gm}{gallon}$

14. $0.789\ \frac{gm}{cc} \times 3785\ \frac{cc}{gal} = 2.99 \times 10^3\ \frac{gm}{gallon}$

15. $\underline{\ 2\ }\ C_8H_{18} + \underline{25}\ O_2 \longrightarrow \underline{16}CO_2 + \underline{18}\ H_2O + \underline{heat}$

16. $\underline{\ 1\ }\ C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O + \underline{heat}$

17. $C_8H_{18} + \frac{25}{2}\ O_2 \longrightarrow 8CO_2 + 9H_2O +$ 1,214 Kcal calculated from the H_f

$$2.62 \times 10^3\ \frac{gm}{gal} \times \frac{1\ mole\ C_8H_{18}}{114.23\ gm} = 22.9\ \frac{moles}{gal}$$

$$1{,}214\ \frac{Kcal}{mole} \times 22.9\ \frac{moles}{gal} = 27,\ 800\ \frac{Kcal}{gal}$$

or

$$110{,}400\ \frac{Btu}{gal}$$

Note Conversion to Btu 3.97 Btu = 1 Kilocalorie

18. $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O + 305.3$ Kcal Calculated from the H_f values list

$$2.99 \times 10^3\ \frac{gm}{gal} \times \frac{1\ mole\ C_2H_5OH}{46.07\ gm} = 64.9\ \frac{moles\ C_2H_5OH}{gal}$$

$$305.3\ \frac{Kcal}{mole} \times 64.g\ \frac{moles}{gal} = 19{,}800\ \frac{Kcal}{gal}$$

or

$$78.600\ \frac{Btu}{gal}$$

Gasohol

Worksheet

Solutions

19. $107{,}000\ \frac{\text{Btu}}{\text{gal}}$ Gasohol

$$110{,}400\ \underset{\text{gasoline}}{\frac{\text{Btu}}{\text{gal}}} \times 0.900\ \text{gal gas} = 9.94 \times 10^{4}\ \text{Btu}$$

$$78{,}600\ \underset{\text{ethyl alcohol}}{\frac{\text{Btu}}{\text{gal}}} \times 0.100\ \text{gal} = \frac{7.86 \times 10^{3}\ \text{Btu}}{1.07 \times 10^{4}\ \underset{\text{of gasohol}}{\frac{\text{Btu}}{\text{gallon}}}}$$

20. (a) $0.40 \times 1.00\ \text{Kg} = 0.40$ Kilogram Methanol

(b) $$\underset{CH_3OH}{\frac{170.9\ \text{Kcal}}{32.05\ \text{gm}}} \times 400\ \text{gm} = 2.13 \times 10^{3}\ \text{Kcal}$$

ADDITIONAL ACTIVITIES FOR GASOHOL UNIT

1. Have students collect newspaper clippings about Gasohol.
2. Construct a bulletin board about Gasohol.
3. Contact Dr. Jim Kendrick, an agricultural economist, at The University of Nebraska - Lincoln for information about food products from fermentation.
4. Try fermenting various grain sources to see what effect different grains have on fermentation.
5. Try varying the temperature to see how that affects the fermentation.
6. Try to isolate methanol from the destructive distillation of wood.
7. Read "Lead From Automobile Exhaust", found in Chemistry, November 1971 and "Smog Formation Simplified", January 1972. Both articles are by Robert Medeiros.

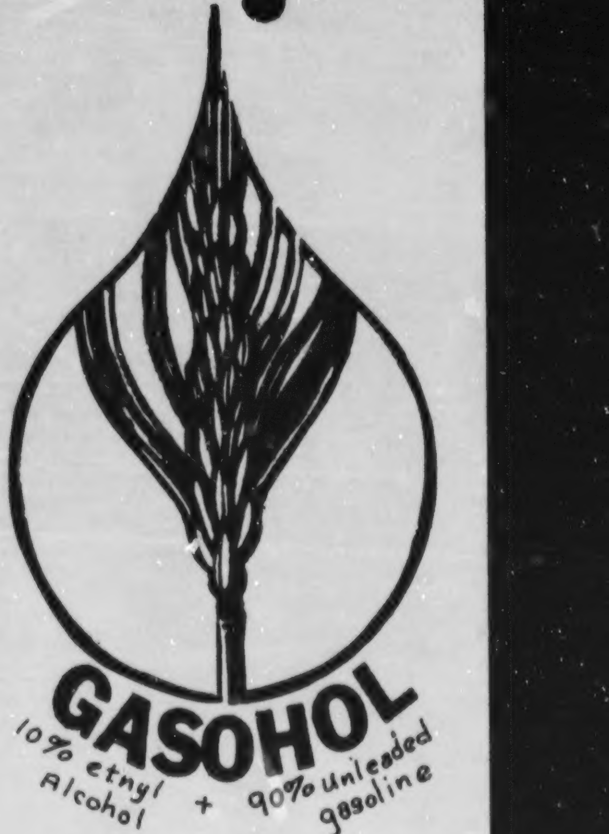
   Be prepared to discuss the kinds and quantities of pollutants produced by burning gasoline and Gasohol.
8. Read "Methanol: A Versitile Fuel For Immediate Use" by T.B. Reed and R.M. Lerner. From Energy: Use, Conservation and Supply, an AAS publication.
9. Write to Agricultural Products Industrial Utilization Committee
   301 South Centennial Mall
   Lincoln, NE 68509

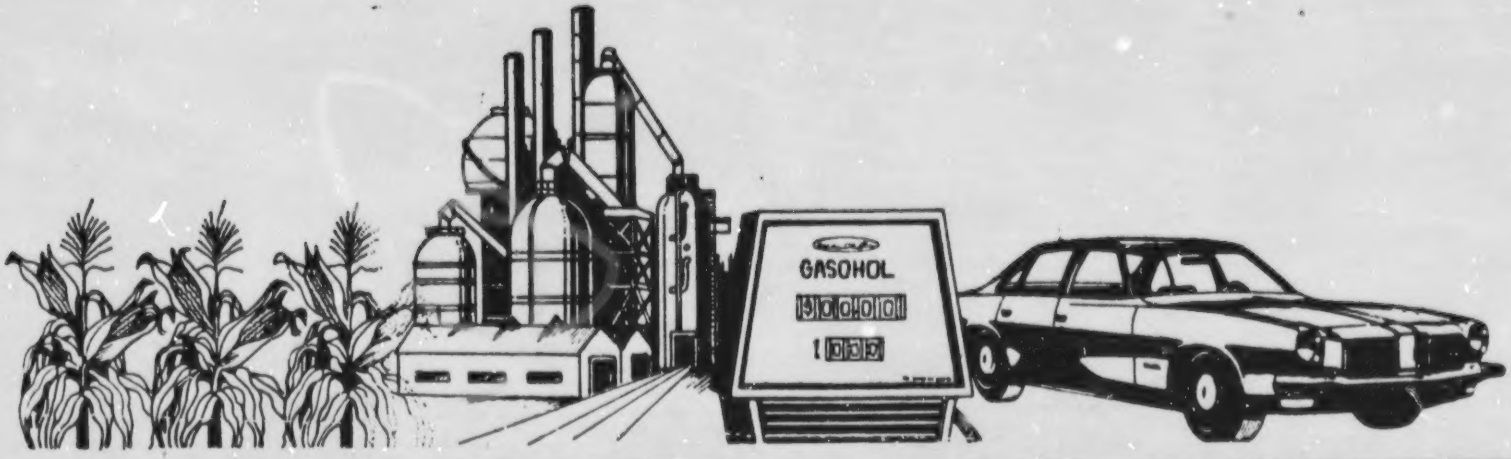
   for additional information, bumper stickers, and a slide/tape program.

Possible Bulletin Boards

LET'S ALL FUEL

AROUND WITH -

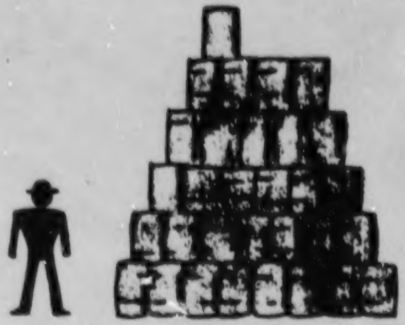

GASOHOL
10% etnyl Alcohol + 90% unleaded gasoline



APPendix 1

The per capita consumption of energy in the U.S. is about 350 million Btu per year. This is approximately

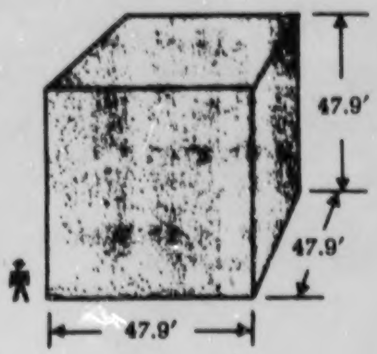
31 barrels of oil



plus

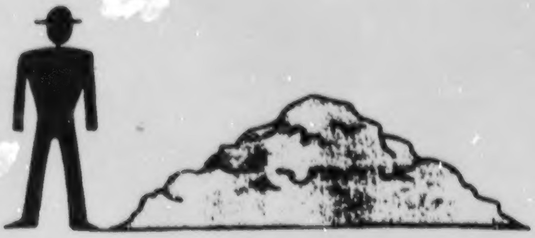
110,000 cubic feet of

natural gas



plus

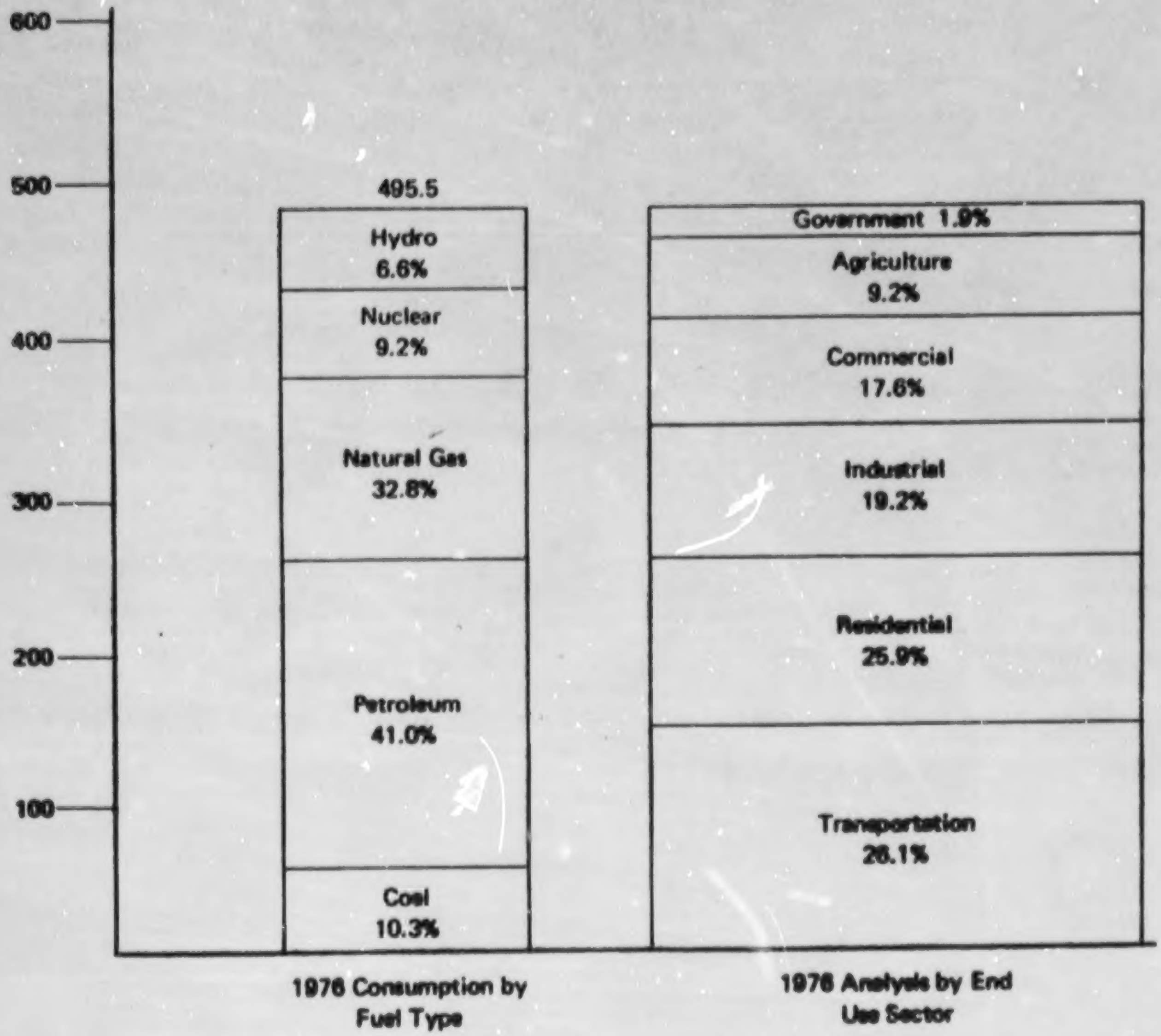
2½ Tons of coal



These three fossil fuels account for about 95% of our national energy budget. About 4% comes from hydro power, and 1% from nuclear.

Energy Activities
Grade 5
Packet "B"
Transparency No. 6
1.2

Nebraska Energy Utilization
1976



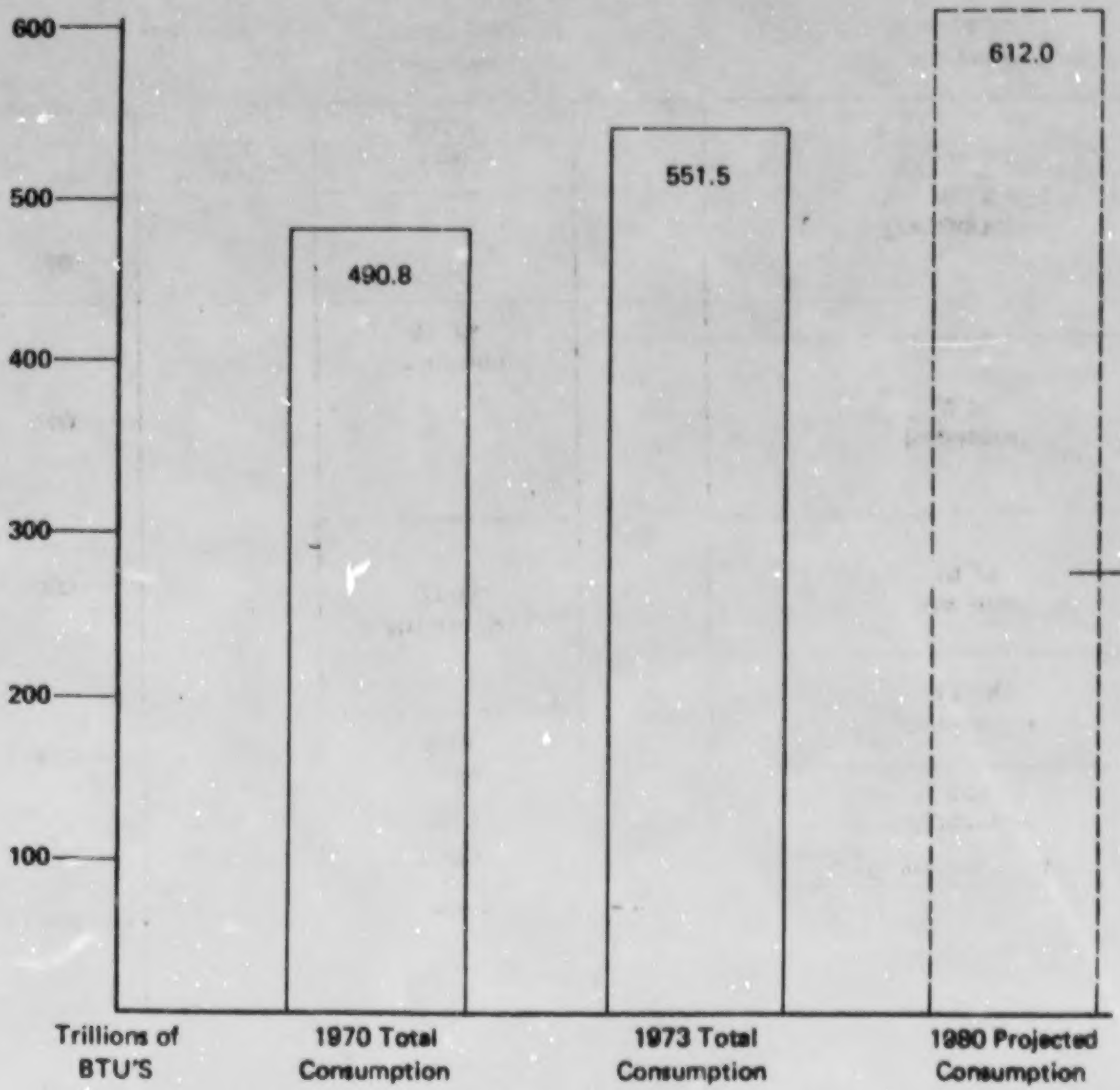
Prepared by the Nebraska State Energy Office June 1977

VII-49

APPendix 2

Energy Activities
Grade 5
Packet "B"
Transparency No. 7
1.2

Nebraska Energy Utilization
1970–1980

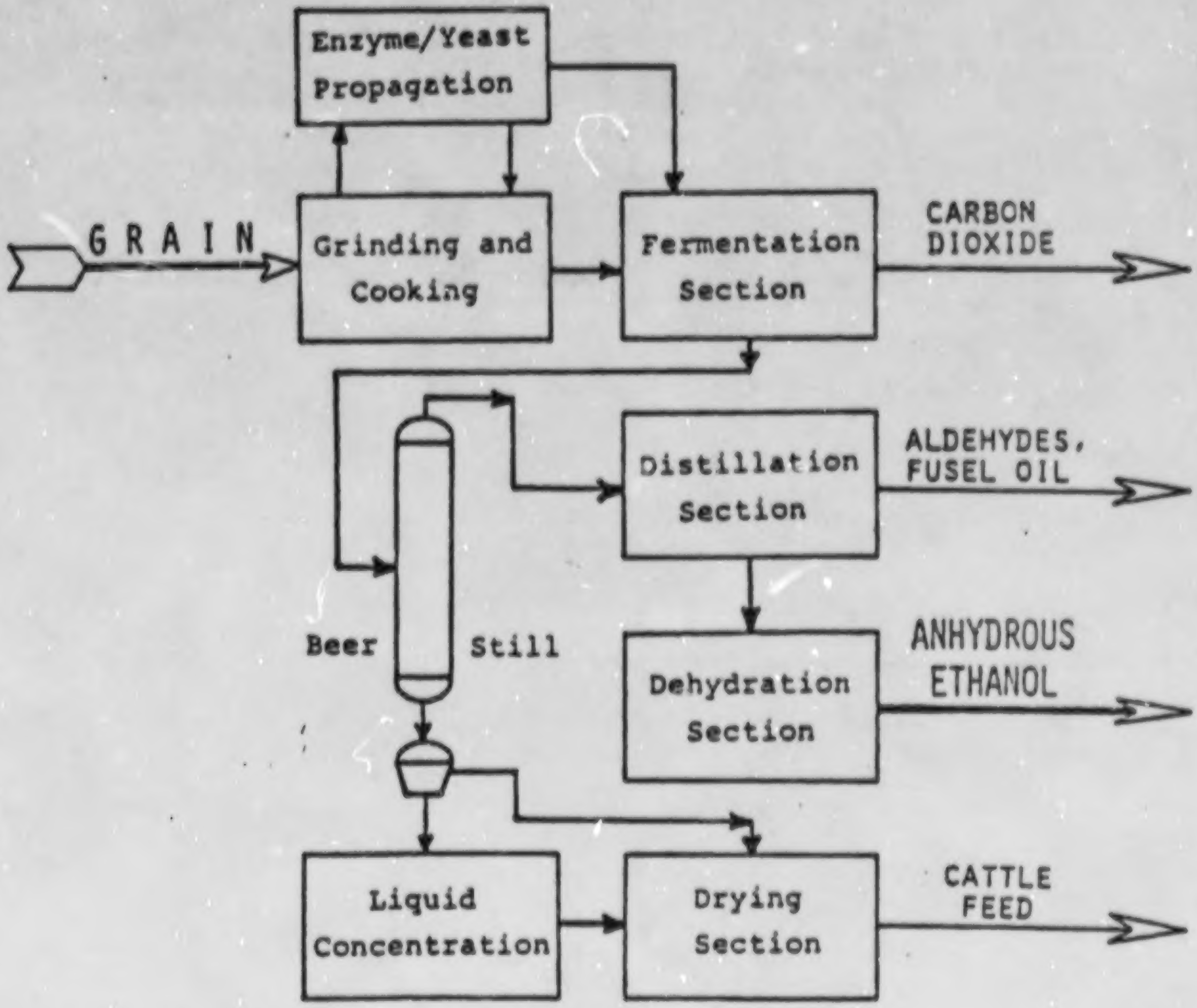


This projection for Nebraska's 1980 total energy consumption was made by the Federal Energy Administration based on 1974 data.

Prepared by the Nebraska State Energy Office June 1977

Appendix S

Appendix 4


Enzyme/Yeast Propagation
GRAIN
Grinding and Cooking
Fermentation Section
CARBON DIOXIDE
Distillation Section
ALDEHYDES, FUSEL OIL
Beer
Still
Dehydration Section
ANHYDROUS ETHANOL
Liquid Concentration
Drying Section
CATTLE FEED

GRAIN ALCOHOL PLANT
FLOW DIAGRAM

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Appendix 5

FACT SHEET ON GASOHOL

1. Gasohol is a blend of 10% agriculturally derived 200 proof anhydrous ethyl alcohol and 90% unleaded gasoline.

2. Gasohol can be burned in any internal combustion engine, regardless of age, without carburetor modification.

3. Gasohol has a higher octane rating than its no-lead component.

4. Gasohol is a cleaner burning fuel than unleaded gasoline. Emissions from Gasohol contain about one-third less carbon monoxide than emissions from unleaded gasoline.

5. Gasohol helps eliminate "dieseling" in many cars.

6. Gasohol will cause no unusual engine wear.

7. Gasohol has been tested in over two million miles of driving in the Gasohol Two Million Mile Road Test without any problems.

8. Gasohol fueled vehicles have consumed 5% less fuel than those vehicles fueled with no-lead gasoline in the road test. In other terms, 6,000 miles of driving with no-lead gasoline expands to 7,000 miles when converted to Gasohol.

9. Consumers purchased almost 93,000 gallons of Gasohol in just 11 weeks in the Holdrege Gasohol Consumer Acceptance Test and Marketing Survey in 1975. Results of this detailed consumer survey in association with this experiment demonstrated consumer acceptance and a demand for a permanent supply of the fuel. The Gasohol Committee concludes from these results that a successful market for Gasohol exists in Nebraska.

10. The alcohol in Gasohol is produced from agricultural products which are renewable resources. The use of agricultural products for producing alcohol helps the farmer by providing a new market for his grains.

11. Alcohol blended fuels such as Gasohol are commonly used in other countries.

12. The use of Gasohol can help the United States reduce its imports of foreign oil.

Provided by the Agricultural Products Industrial Utilization Committee, State of Nebraska

For more information on Nebraska's Gasohol Program, please contact:

Administrator
Agricultural Products Industrial Utilization Committee
3rd Floor
301 Centennial Mall South
Lincoln, Nebraska 68509
Phone: (402) 471-2941

APPENDIX 6, PAGES VII-53 THROUGH VII-58 REMOVED DUE TO COPYRIGHT RESTRICTIONS

CONSERVATION WITH THE "DOUBLE NICKEL" AND CARPOOLING

by Roy Rubenking

Grade Level: 8-12
Time Required: Open Ended
Recommended Subject: Science and Social Studies

Prepared for

the Nebraska Energy Office

Overview

Traveling the highway indicates that people in general do not see the need for conservation of our petroleum supplies, nor do they believe that 55 mph does conserve, or are not willing to "spend" the time. The goal of this science project is to educate a selected group of students and drivers to the economic impact of operating an automobile at the speed limit of 55 verses the operation of the same vehicle at 65 mph. We will also determine approximate savings with the use of carpooling. We are using cost as the main emphasis because people are interested in saving money, which ultimately conserves fuel.

The data gathered from participating drivers will be used in the following ways:

a. fuel consumption compared by size of vehicle

b. calculate approximate savings in fuel and costs by observing the speed limit

c. calculate approximate savings in fuel and costs by use of carpooling

d. as an educational tool for students

e. as an educational tool for participants

f. to simplify the project only commuting miles will be considered

Recommended level

Junior High

Senior High

Time required

This study should be used as a project. Data should be compiled for a selected time period. The longer the time period the greater the validity. There is no way of predicting the actual amount of class time needed because of variables in collecting data and student ability.

Major teaching strategies

I recommend group research, observation, class discussion, comparison, grouping, skill development, and inquiry.

Essential advance preparation

All necessary materials are included in this project unit. Some handouts are suggested to increase interest.

Goals

Involve people personally, to help them think conservation of energy.

Use local drivers as a source of information (localize).

Show a select group that 55 mph highway driving conserves fuel and saves money.

Show that carpooling conserves fuel and saves money.

Objectives

Because of working with this project material, the student will:

1. Collect and organize data.
2. Calculate average miles per gallon consumption figures for vehicles.
3. Show by calculations and grouping how size of vehicle relates to fuel consumption.
4. Use averages for observation and data processing purposes.
5. Determine the effect of 55 mph driving vs 65 mph driving on fuel consumption.
6. Discuss other fuelish driving habits.
7. Determine the effect of carpooling on fuel consumption and commuting costs.

Activities

To begin the project it is suggested that the teacher make copies of student materials #1 and #2; then distribute a copy to each student. After allowing time to look it over, discuss the contents.

According to the April, 1977, Energy Plan, the automobile consumes 5,000,000 barrels of oil per day in the United States. An excellent "handout" which gives an overall view of the transportation sector is Fact Sheet #11; Energy Conservation, Transportation. These may be obtained free from two sources:

Gary A. Lay
Education Coordinator
Nebraska Energy Office
Box 95085
Lincoln, NE 68509

DOE-Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

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After the previous discussion, begin introducing the project by discussing data gathering methods. After this, hand out the data collecting form (found in student materials). Discuss this thoroughly so the students understand the contents and purpose. The next step is to assign students to find volunteer drivers (teachers, students, parents) who are willing to take the time to document the data for your selected time period. After this time period is over students should collect their data sheets from the volunteers.

Assign numbers to all participants and put these numbers of both their data collecting form and their individual data sheet. It was our experience in testing this material that some commuters used fuel from a barrel. If this happens in your "study" they usually know approximate mpg figures of their vehicles and the price they pay for the fuel. If they do not, their material cannot be used. Otherwise do not use calculations #3, #4, #5, #6, and #7 on the instruction sheet. Put their miles per gallon figure on #3 of their individual data sheet and their cost per gallon figure on #4. The remainder of the instructions is valid for them.

Hand out to the students copies of the four instruction sheets and enough copies of the individual data sheets to cover their volunteers. These are found in the student materials section. These instructions are a little hard to follow so they are cross referenced by number to make it easier   Before starting calculation #8 they will need the sheet titled "Effect of Speed on Fuel Consumption Rates:Cars and Trucks." This is also found in the student materials section. (We found the per cent increase in fuel consumption for calculation #12 to be between 12 and 13 per cent.) Have the students finish all instructions.

After the students finish filling out all data sheets, ask them is there is a way to catagorize the vehicles they have. This should lead into four or five types by size. Compare the types of vehicles and their mpg figure (#3 data sheet). Discuss the results. Can the students draw any conclusion? (Smaller vehicles use less fuel; get more miles per gallon).

Lead the discussion into the 55 mph speed law. (pro and con) a. saves fuel, b. highway deaths are down, c. vehicles last longer, d. cost per mile is down, etc. Discuss their figures (from #14 and #17 of data sheet) and draw conclusions. (Hopefully they will generally conclude tyat the speed limit saves enough fuel to make slower driving worth doing.)

Ask the class their opinion of carpooling to save fuel. According to the April, 1977, National Energy Plan, if 4 commuting cars out of 10 carried 1 additional passenger; 400,000 barrels of oil a day would be saved. Give them this information, then have them check their data (#15 data sheet).

Evaluation suggestions are given on the next page.

Discussion suggestions are given in the student materials.

After you are done, hand the completed individual data sheet and their data collecting form back to the participating driver so they can see the results of the study.

Evaluation suggestions

This is a proposed evaluation (you may make your own if your objectives differ)

1. What do you think was the most difficult part of this project?
2. If someone told you he averaged 44 miles per gallon with his vehicle, what type of vehicle would you suspect it to be?
3. If a vehicle averages 20 miles per gallon, how far would you expect it to go on 15 gallons of fuel?
4. Why are averages useful in projects such as this?
5. For what purpose was the 55 mile per hour speed limit made a law?
6. What side effect to the 55 mile per hour law has been observed across this country?
7. What are two of the greatest drawbacks to economy vehicles?
8. What is the biggest objection to the speed law?
9. In what way will carpooling help cities?
10. Approximately what percent less fuel is consumed by a vehicle by driving 55 mph. instead of 65 mph.?

ANSWERS TO EVALUATION

1. Answer will vary but should indicate involvement
2. Small car or motorcycle
3. 300 miles
4. Answers may vary but the idea should be to group items or to use one figure for many items
5. To save fuel
6. Fewer highway deaths (consider others)
7. Small, dangerous to occupants in case of accidents (consider others)
8. Time consuming
9. Less traffic on streets, less polution
10. About 10% or the figure that was decided on in the project

Helpful resources

The National Energy Plan (available from)

Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

Proceedings of the Fourth National Conference
Effects of Energy Constraints on Transportation Systems

(available from) National Technical Information Service (NTIS)
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Fact Sheet #11; Energy Conservation, Transportation

(available from) Gary A. Lay
Education Coordinator
Nebraska Energy Office
Box 95085
Lincoln, Nebraska 68509

(or) DOE- Technical Information Center
P. O. Box 62
Oak Ridge, TN 37830

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STUDENT MATERIALS #1

According to "The National Energy Plan" (April, 1977), cars consume 5,000,000 barrels of oil a day in this country.

"Wasted energy in cars, homes, commercial buildings and factories is greater than the total amount of oil imports."*

"America needs to embrace the conservation ethic. The attitudes and habits, developed during the era of abundant, cheap energy, are no longer appropriate in an era of declining supplies of America's predominant energy resources. As individuals find new ways to save energy in their daily lives, they will reduce their own energy bills and contribute to the future well-being of the country."*

This project is designed to gather information from your area to find out if petroleum energy is being conserved through the use of the 55 mph. speed limit and ride-sharing, (carpooling).

You will need to gather information from teachers, fellow students, parents, neighbors and friends, the information that you will need to collect is illustrated on the data collecting form.

---

* "The National Energy Plan, April, 1977

Student materials #2

NEBRASKA MOTOR GASOLINE HISTORY

REPORTED METERED GALLONS

	1973	1974	1975	1976	1977	1978
JANUARY	65,538,891	63,099,642	65,351,844	67,344,839	72,221,822	72,860,869
FEBRUARY	60,942,328	57,529,194	55,922,993	61,725,022	65,210,382	67,081,186
MARCH	72,317,310	69,254,233	62,063,360	74,528,127	73,654,069	79,341,580
APRIL	72,469,418	71,308,785	69,402,698	79,628,646	80,250,103	78,845,541
MAY	79,469,418	74,140,795	80,370,445	80,154,843	82,353,669	89,440,001
JUNE	79,374,313	76,635,327	79,591,082	88,543,640	90,525,624	92,401,182
JULY	83,798,474	83,373,373	88,971,574	92,183,910	96,937,085	
AUGUST	88,216,998	80,118,302	82,772,411	87,133,409	86,785,567	
SEPTEMBER	73,986,379	71,431,604	74,593,620	80,850,143	84,058,046	
OCTOBER	83,372,072	79,340,663	81,336,186	86,139,546	86,001,456	
NOVEMBER	79,416,326	70,282,127	62,318,238	78,366,485	80,274,889	
DECEMBER	68,404,041	71,323,191	71,461,383	78,302,154	79,568,620	
TOTAL	907,305,968	867,837,236	874,155,834	954,900,764	977,841,332	479,970,359

Percent Change

1973-74 = -4.4%
1974-75 = 0.7%
1975-76 = 10.0%
1976-77 = 2.6%

1973-77 = 8.0%
1974-77 = 12.9%
1975-77 = 12.2%

PREPARED BY THE STATE ENERGY OFFICE

August, 1978

VIII - 9

DATA COLLECTING FORM number ______

Type of vehicle used for commuting: (circle one)

Large car, intermediate car, small car, pickup, motorcycle

How many miles do you live from work or school? ____________

Please record the dates that you drive the above vehicle to work or school.

____

____

____

____

Please record the dates that you ride with someone else to work or school.

____

____

____

____

Please record the following information each time you purchase fuel for the above vehicle.

Speedometer reading	gallons purchased	total cost

INDIVIDUAL DATA SHEET Number _____

1. Vehicle commuting miles ______
2. Vehicle was not used because of carpooling _______ (miles)
3. Average miles per gallon of vehicle _______
(calculation #6)
4. Average cost of gallon of fuel ______
(calculation #7)
5. Per cent increase of fuel consumption from 55 mph to 65 mph
(calculation #12) _____%
6. Gallons consumed commuting _____
(calculation #13)
7. Fuel savings driving 55 mph ______
(calculation #14)
8. Money saved driving 55 mph _____
(calculation #15)
9. Fuel saved carpooling _____
(calculation #16)
10. Money saved carpooling _____
(calculation #17)
11. Fuel saved by slower driving and carpooling _____
(calculation #18)
12. Money saved by slower driving and carpooling _____
(calculation #19)

COLLECTIVE DATA FROM STUDY

13. Number of drivers involved _____
14. Total fuel saved by 55 mph speed law ______
15. Total fuel saved by carpooling ______
16. Fuel saved by both methods _____
17. Money saved by slower driving _____
18. Money saved by carpooling _____
19. Money saved by both methods _____

INSTRUCTION SHEET page 1

Assign numbers to all participants and put these numbers on both their data collection form and their individual data sheet. From each data collecting form calculate the following:

1. To find the number of miles the vehicle was used for commuting to work or school, multiply the number of days driven by the number of miles to work. Then multiply this figure by 2.

   Vehicle commuting miles = days X miles X 2

   Record this figure on the data sheet, #1.

2. To find the number of miles that the vehicle was not used because of carpooling, multiply the number of days the commuter rode with someone else by the number of miles from work. Then multiply this by 2.

   Miles saved = days X miles X 2

   Record this figure on the data sheet #2.

3. Next find the number of miles the vehicle was driven during the data collecting period. To find this, subtract the initial speedometer reading from the final speedometer reading on the data collecting form. This is needed later to calculate the average miles per gallon figure for the vehicle (calculation #6).

   Total miles = final speedometer reading - initial reading

4. Next find the number of gallons the vehicle consumed during the data collection period. The gallons of the first purchase are not included because the mileage was not recorded for this amount of fuel used so cannot be included in consumption calculations.

   Total gallons used = add gallons column (do not include first one)

   This figure will be used later in calculations #6, #7.

5. Then find the total cost of the fuel used in the data collecting period. Here again the first amount is not used. The reason is the same as in calculation #4.

   Total cost of fuel = add cost column (do not inclued first one)

   This figure will be used later in calculation #7.

FROM THE ABOVE CALCULATE:

6. This gives the average number of miles the vehicle can travel on one gallon of fuel. Divide the total miles (from #3 above) by the total gallons (from #4 above).

   $$\text{MPG} = \frac{\text{miles (\#3 calculation)}}{\text{gallons (\#4 calculation)}}$$

   Record this figure on the data sheet #3.

7. This gives the average cost of a gallon of fuel that this vehicle consumed during the data collecting period. Divide the total cost for fuel (from #5 above) by the total gallons (#3 above).

   $$\text{CPG} = \frac{\text{cost (\#5 calculation)}}{\text{gallons (\#3 calculation)}}$$

   Record this figure on the data sheet #4.

Use the sheet entitled "Effect of Speed on Fuel Consumption Rates: Cars and Trucks" to calculate a percent increase between 55 mph and 65 mph. The next calculations will show you how.

8. Since this chart gives fuel consumption figures for 50 and 60 mph and we need them for 55 mph (our speed limit) this calculation gives us that figure. We need to do this twice; once for the cars with air conditioning and once for those without. To find the miles per gallon consumption rate from the chart add the miles per gallon figures at 50 and 60. Divide this by 2. This will give you a miles per gallon figure for 55 mph.

   $$\text{mpg at 55} = \frac{\text{mpg at 50} + \text{mpg at 60}}{2}$$

9. This calculation gives us the needed miles per gallon figure for 65 mph (the old speed limit). This calculation also has to be done twice; once for air conditioned cars and once for those without.

   $$\text{mpg at 65} = \frac{\text{mph at 60} + \text{mpg at 70}}{2}$$

10. This calculation averages the miles per gallon consumption figures at 55 mph of cars with air conditioning (w) and those without (wo). Use the figures from the calculations on #8.

    $$\text{Average mpg at 55} = \frac{\text{mpg at 55 (w)} + \text{mpg at 55 (wo)}}{2}$$

11. This calculation does the same as the above for the 65 mph speed. (Use figures from calculation #9)

$$\text{Average mpg at 65} = \frac{\text{mpg at 65 mph (w)} + \text{mpg at 65 mph (wo)}}{2}$$

12. This calculation uses the figures from calculations 10 and 11 for finding average per cent of increase of fuel consumption. We will use this figure later for calculating approximate fuel savings in our study by driving 55 mph.

$$\text{\% increase} = \frac{\text{average mpg at 55} - \text{average mpg at 65}}{\text{average mpg at 65}}$$

Record this figure on all data sheets #5.

Now we can calculate fuel and cost savings for the individual vehicles of the study with the 55 mph speed limit as compared to the old 65 mph speed limit.

13. First we have to calculate the number of gallons consumed for the commuting miles of the vehicle. This is done by dividing the total commuting miles (#1 data sheet) by the average miles per gallon figure (#3 data sheet).

$$\text{gallons consumed} = \frac{\text{commuting miles (\#1 data sheet)}}{\text{mpg (\#3 data sheet)}}$$

Record this figure on the data sheet #6.

14. Now we can calculate fuel savings with the current 55 mph speed law verses the old 65 mph speed law. We do this by multiplying the gallons consumed (#6 data sheet) by the percent increase of fuel consumption figure (#5 data sheet).

fuel saved = gallons consumed (#6) X percent increase (#5)

Record this figure on the data sheet #7.

15. Now we can calculate the amount of money our commuters saved by driving slower. We do this by multiplying the amount of fuel saved (#7 data sheet) by the average cost per gallon (#4 data sheet) of the fuel they bought.

Money saved = fuel saved X cost per gallon

Record this on the data sheet #8.

16. We will now calculate the fuel savings from carpooling. To do this divide the miles which the commuter rode with someone else (#2 data sheet) by the average mile per gallon figure

the vehicle gets (#3 data sheet).

$$\text{Fuel saved} = \frac{\underline{\text{carpooling miles}}}{\text{mpg}}$$

Record this fuel savings on #9 data sheet.

17. We will now calculate the amount of money the commuter saved by carpooling during our study period. To calculate this we multiply the fuel saved by carpooling (#9 data sheet) by the average cost per gallon (#4 data sheet).

    Money saved = fuel saved X cost per gallon

    Record this on # 10 data sheet.

18. Now total the fuel saved by slower driving and carpooling.

    Total fuel saved = 55 mph (#7 data sheet)+carpooling (#[illegible])
    Record this answer on #11 of the data sheet.

19. Total the money saved by both methods.

    Total money saved = 55 mph (#8 data sheet)+ carpooling (#10)
    Record this answer on #12 of the data sheet.

The remainder of the data sheet is filled out by totaling information from all the individual data sheets and the same figures are recorded on all data sheets.

For #:
13. Total the number of drivers

14. Total #7

15. Total #9

16. Total #14 and #15 on one data sheet and list on all data sheets (they well be the same).

17. Total #8

18. Total #10

19. Total #17 and #18 on one data sheet and list on all data sheets (they will be the same).

Effect of Speed on Fuel Consumption Rates: Cars and Trucks

	Miles per gallon at selected speeds					Percent increase in gasoline consumption caused by increase in speed				
	30	40	50	60	70	30-40	40-50	50-60	60-70	50-70
Cars without air conditioning	21.05	21.07	19.49	17.51	14.93	0.00	8.11	11.31	17.28	30.53
Cars with air conditioning	18.14	17.51	16.42	15.00	13.17	3.60	6.64	9.47	13.90	24.68
Percent improvement in MPG after tuning	10.52	12.92	9.54	11.04	15.32					
	50	55	60	65		50-55	55-60	60-65	50-60	50-65
Heavy-duty highway trucks	5.11	4.81	4.54	4.09[1]		6.20	6.66	5.50[1]	12.48	23.30[1]
Percent increase caused by wound-up driving[2]	14.4	8.0	7.6							

[1] Only three of the six test vehicles were operated as the governor setting that controls fuel injection did not permit the other three vehicles to be operated at 65 miles per hour.

[2] Wound-up driving is driving a diesel truck at or near its maximum horsepower. It results in an increase in miles per hour but a decrease in miles per gallon, especially on downgrades.

Source: E.M. Cope, U.S. Department of Transportation, Federal Highway Administration. The Effect of Speed on Automobile Consumption Rates, Washington, D.C., August, 1974, p. 14.

THINGS TO THINK ABOUT!

1. If a car comsumed 10 gallons of gas while traveling 120 miles, what is its average miles per gallon figure?
2. If you had a 1970 car in good shape, but it's average miles per gallon figure was only 14; would it be more economical to trade it for a new gas conserving (22mpg) model, or keep it? (How long would it take you to consume enough fuel to equal the cost of the new car after tradein?)
3. Take a look at four modes of personal transportation; large car, intermediate car, small car, motorcycle. a. Which vehicle uses the least fuel? b. Which vehicle is the safest in an accident? c. Which vehicle has the greatest drawback in foul weather? d. Which vehicle(s) does and does not work well with large families? e. Which vehicle costs most to buy and operate? f. What things need to be considered by an average American in need of transportation vehicle?
4. How can all drivers save fuel and expenses? How many fuel consuming driving habits can you name?
5. How does carpooling save fuel and expenses?
6. What are some of the drawbacks of carpooling:
7. Is conservation of fuel important? Do you think people will conserve fuel on their own or do you think they will have to be forced?

ECONOMICS AND ENERGY

Recommended Level: Senior High Economics
Time Required: 12 to 14 Class Periods

by
Don Beckenhauer

Prepared for
The Nebraska Energy Office

OVERVIEW

In a nation as new as the United States and one which has epitomized the motto "land of plenty", it is difficult but essential to bring our youth to the realization that the energy shortage is real and will effect our daily lives. One focus can be upon the dwindling oil supply, the need to search for and accept other sources of energy, and the effect on our economy that results.

By using the economic principle of supply and demand, it is possible to better understand how oil prices are determined. Once the students have accompolished this concept, they can predict what can be expected as to the cost of oil and it's supply, if oil is to be freely traded on the market place.

A second forecast can then be prepared, concerning the supply and cost of oil, under the conditions of rationing of oil and government control of prices. Once the projection of the future price of oil and it's supply has been accomplished, students will study and develop alternative sources of energy.

RECOMMENDED LEVEL

This unit is for use in the senior high in a economic class or as a unit in another social studies class. Background information is included for those instructors wishing to adapt this unit to their discipline.

TIME REQUIRED

The time needed for this unit will be twelve to fourteen class periods.

MAJOR TEACHING STRATEGIES

The unit can be accomplished through class discussion, presentation by outside authorities, simulation activities, debate and field trip, the use of slide picture presentation and television programs.

ESSENTIAL ADVANCE PREPARATION

To insure the success of the unit, the instructor should have on hand or have arranged for the following:

- reading resources,
- guest speakers,
- television set,
- television tapes,
- slide projector,
- tape player,
- slide and tape series
- graph paper.

GOALS

Students will become conscious of the energy shortage and its effect on the United States.

Students will be able to identify and understand the economic problems relating to energy.

Students will become familiar with other sources of energy available for development and use in this country.

OBJECTIVIES

The student will be able to:

1. Construct a supply curve from a given supply schedule,
2. Construct a demand curve from a given demand schedule
3. Locate the equilibrium point from given supply and demand schedule and know that this is the price and quantity that business will be done.
4. Predict with supportive evidence the future price of oil,
5. Give judgement with evidence or reasoning as to the effect of oil rationing.
6. Identify the strong and weak points of: nuclear energy, coal energy, solar energy and other energy sources that students are interested in.

DAILY LESSONS

Day One:

Motivation.

Slide pictures and tape presentation,

Critical issures in Science and Society: The great Energy Debate.

Discussion: Do we have an energy shortage?
How are prices of oil and gas arrived at?
Any other questions that students wish to discuss.

Day Two:

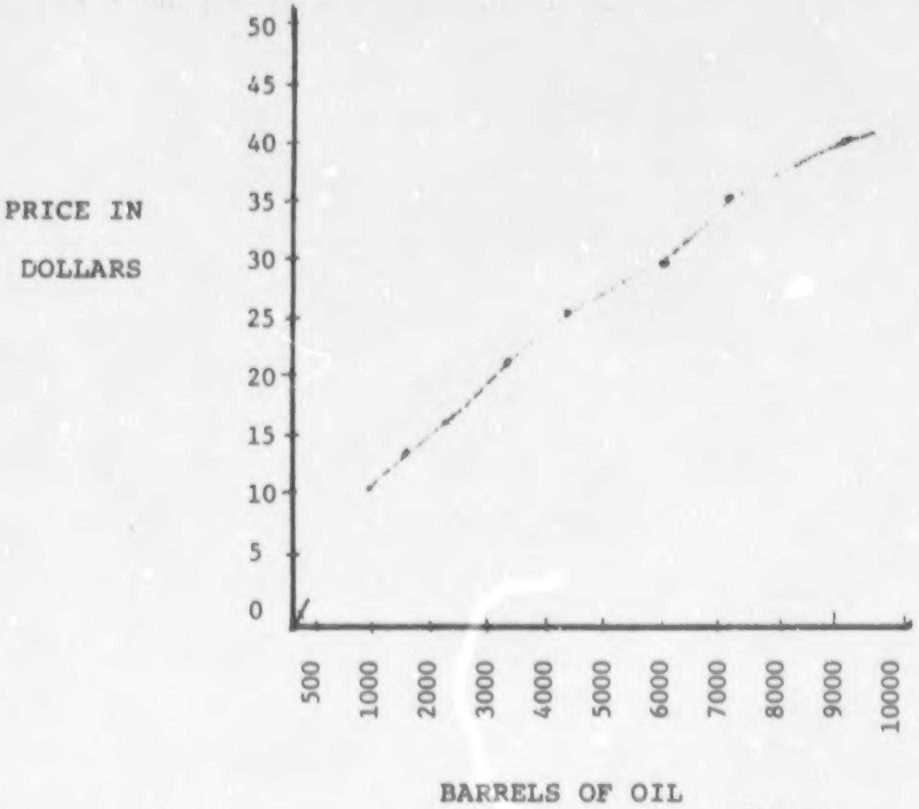
Provide students with a supply schedule and a demand schedule. Explain to the students:

1. How it is constructed,
2. How it is interpreted, (consult Appendix A)

SUPPLY SCHEDULE

Price	Additional units barrels of oil	Total units barrels of oil
$ 1	100	100
4	200	300
8	400	700
12	600	1300
16	800	2100
20	1000	3100
24	1200	4300
28	1400	5700
32	1600	7200
36	1800	9100

Have students construct a supply curve on graph paper. Explain what this represents.



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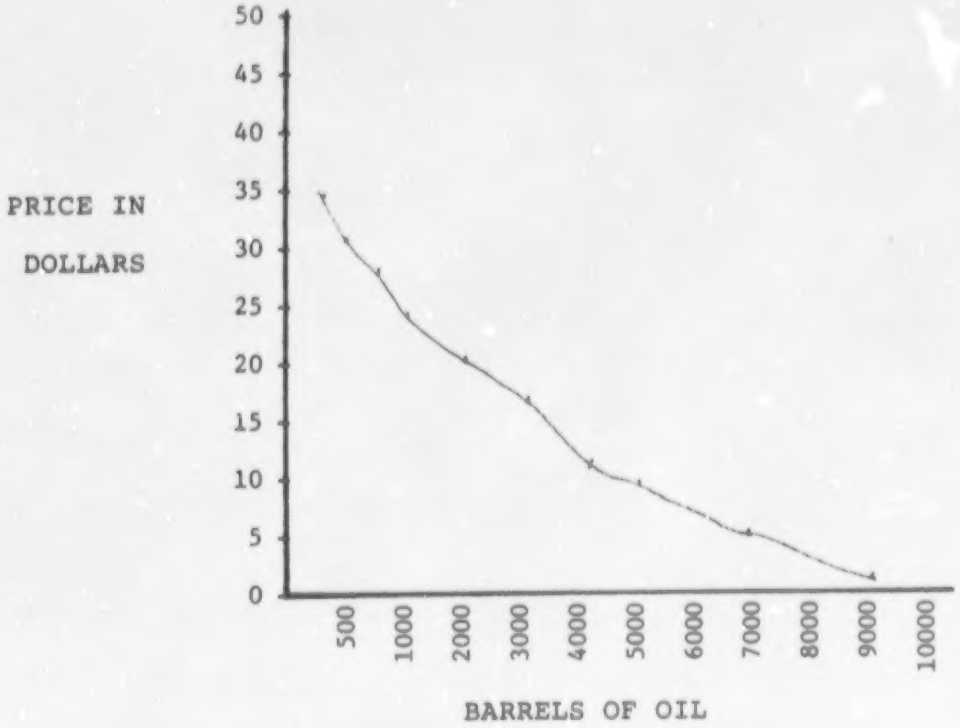
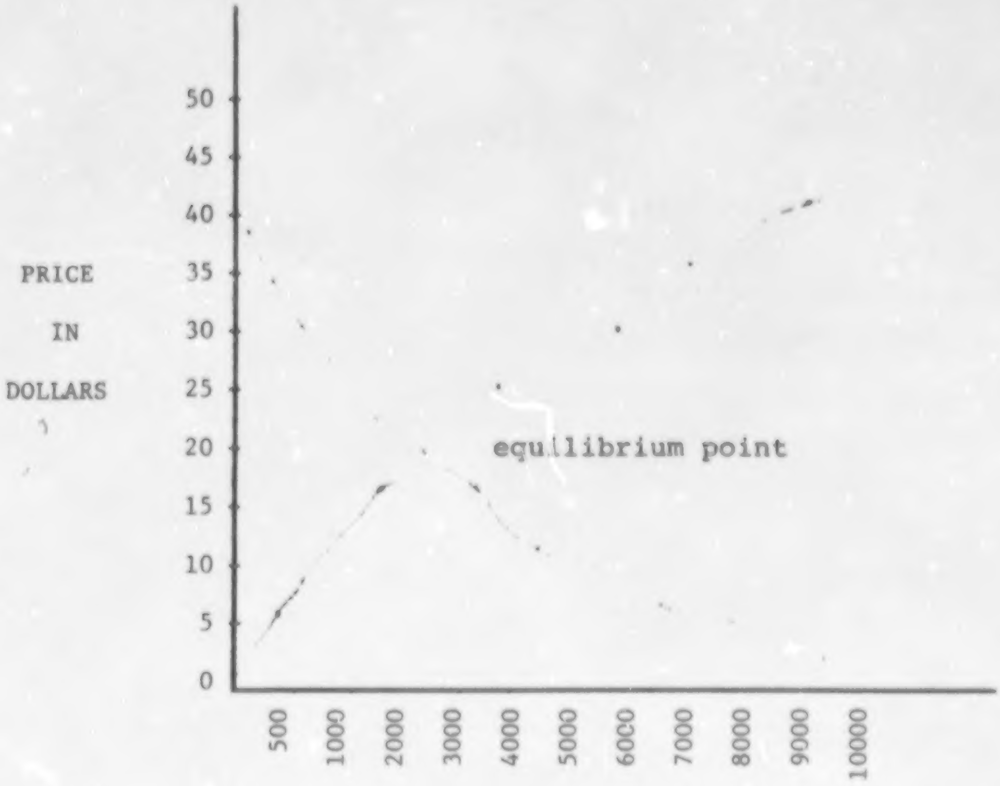
DEMAND SCHEDULE

Price	Additional units barrels of oil	Total units barrels of oil
$ 36	100	100
32	200	300
28	400	700
24	600	1000
20	800	2100
16	1000	3100
12	1200	4300
8	1400	5700
4	1600	7300
1	1800	9100

Have students construct the demand curve on graph paper. Explain what this represents.



Have students put both the supply curve and the demand curve on the same graph. Explain to students that the intersection of the demand and supply curve is the equilibrium point. For a given demand schedule and supply schedule, the equilibrium point is the amount of units that will be bought and the price at which business will be done.



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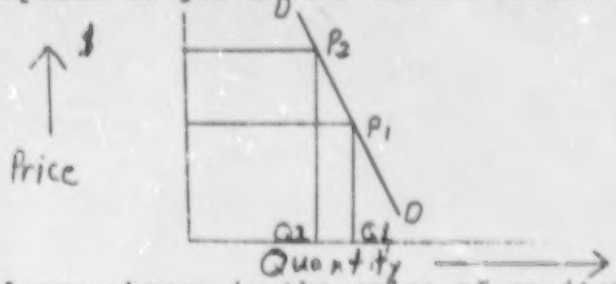
Day Three

Provide data on oil reserves and oil sources for the United States. Provide data on how many oil companies there are and their size in dollar volume of business.

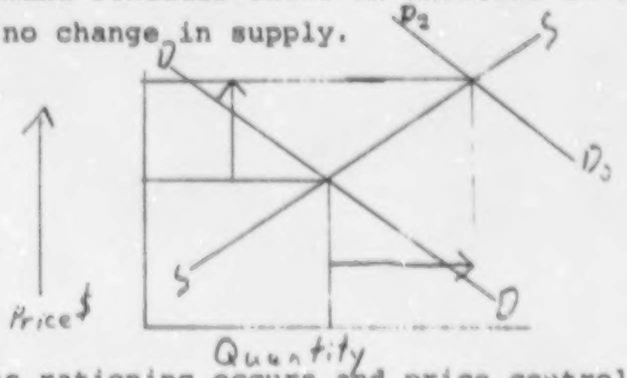
Have class come to an agreement as to the answer of this question: To what extent does the cost of gas effect the consumption of gas in the United States.



If a large change in the price of an item brings about a small change in the volume consumed that demand is inelastic.

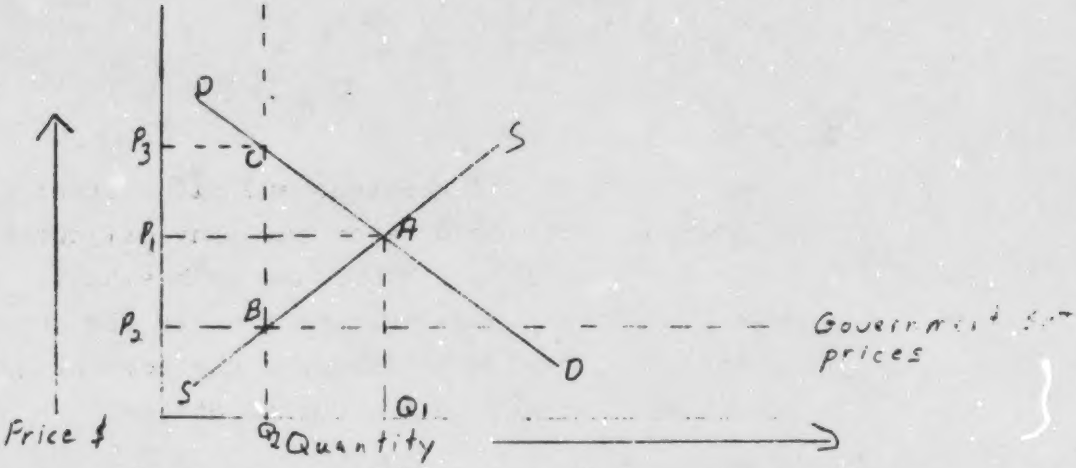
Have class forecast as to the future price of oil and give some evidence they are right.

Have class determine or analyze what will happen to the supply of oil and what will happen to the cost of oil, if the demand schedule shows an increase in demand and there is no change in supply.



Price went up
Supply increased

If gas rationing occurs and price controls take place, have the class forecast what might happen to supply, price paid, and who might control supply of gas. Have class tell why they think that way.



Students will be able to see that if normal prices is P_1 and the government sets prices at P_2 that the quantity supplied will drop from Q_1 to Q_2. At the new quantitity, we would be willing to pay P_3. The difference between the price you can sell and the price people are willing to pay could lead to unlawful activities.

Day Four

Have Dean Metz from Wayne State present and explain the Energy Simulator. Students will be able to see relationships between decision making today and future effects on resources.

Day Five

List alternatives to oil as a source of energy. Quickly go over the alternatives to oil as a source of energy. Have class determine what alternatives we want to examine more closely. Divide the class into task forces for in-depth study.

Day Six

Research alternatives and prepare for day eight and nine.

Day Seven

Rsearch alternatives and prepare for day eight and nine.

Day Eight

Debate as to the feasibility of nuclear energy.

Day Nine

Panel discussion on use of solar energy.

Day Ten

Speaker from Nebraska Public Power District, on its energy sources, use of coal and nuclear power.

Day Eleven

Field trip to Hydro plant at Loup Power Plant. (optional)

Day Twelve

Field trip to either a coal station or nuclear power station of Nebraska Public Power District. (optional)

Day Thirteen

Summarize what was learned on the field trips. Review of unit.

Day Fourteen

Test and evaluation for students.

EVALUATION SUGGESTIONS

Evaluation will be informal on a subjective base from day to day as the unit progresses. At the end of the unit the students may be given a test. Questions that could be used are given below.

-- Many people feel that the oil and gas prices should be determined by the market place. If this did occur, what would happen to the price of gas that they buy? Provide evidence to support your answer.

-- Many people feel that oil and gas should be rationed and the price controlled by government. If this were to happen, forecast what might happen to the supply of oil and gas, and what will be the tendency as to price? Provide evidence for your answer.

-- What energy source do you favor as a means of supplying our energy needs of the future? Include why you favor this source and the advantages as well as disadvantages of this energy source.

-- What steps would you take if you were an administration energy advisor in charge of making Americans aware of the energy shortage?

I. Appendix A - Basic Concepts of Economics Necessary to this Unit.

(In order to adopt this unit to classes other than economics, it is imperative that the teacher have a basic understanding of the concepts and terms used. Please consult the glossary in Appendix B. Appendix C contains a list of suggested readings that will enable the teacher to expand his/her own knowledge. These books are available in the Love Library at the University of Nebraska - Lincoln. If these texts are unavailable it is suggested that you obtain a basic economics text from your school library. A programmed approach may prove particularly useful.)

For you to teach your students about supply and demand, it is necessary for you to understand the basic concepts and principles. First read the glossary in Appendix B and then proceed.

Note that supply and demand are different than the Laws of Supply and Demand. As a general rule, consumers buy more of a product at lower prices and suppliers sell more of a product at higher prices. This is the basic tool with which economists work to determine the market price.

Let's examine the supply schedule on page 3 first. Two variables are involved: price and quantity. The costs to produce a product determines a seller's supply schedule. At higher prices there is usually more incentives to offer a greater amount of product for sale. Note the seller has listed his willingness to sell 100 barrels of oil for one dollar. He is also willing to sell relatively more (1,800 barrels of oil) for the money ($36.00). In other words, the seller is saying the more money a buyer is willing to invest in his purchase, the more product I am willing to sell for that money.

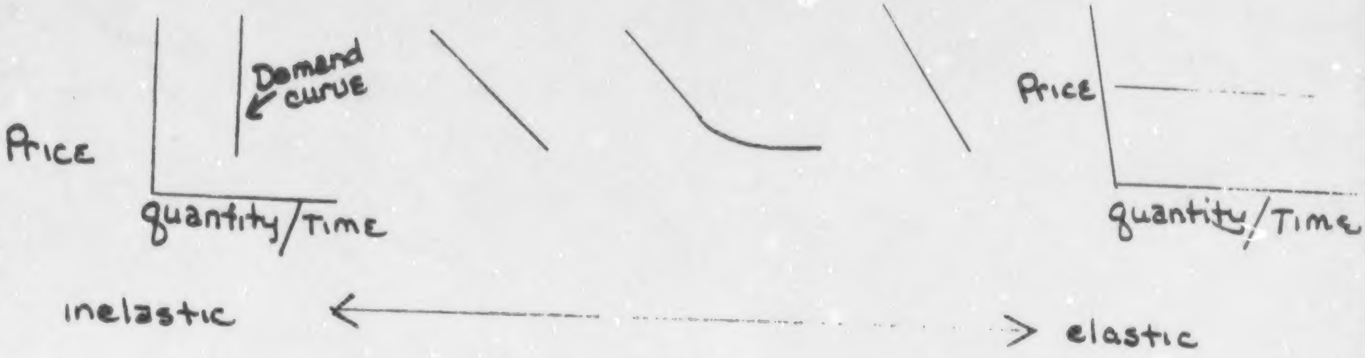
To better understand this the economist will graph the supply schedule. On page 4, the total units of barrels of oil (the horizontal parameter) has been plotted against price (the verticle parameter).

The demand schedule is handled in much the same way. Examine page 5. Here you will see that the buyer is telling the seller to lower his price in order to sell large quantities. The buyer has only so much money he is willing to invest in buying a certain quantitity.

As with the supply schedule, the demand schedule has been graphed using the same parameters.

When the two graphs are combined, the intersection of the supply curve and demand curve becomes important. It is at this point both buyer and seller will agree to conduct business (the equilibrium point) and the market value of the product is established.

If supply and demand curves are observed over a period of time and change a characteristic called elasticity becomes obserable. In general, a product that is purchased in the same amount despite the increase in cost is perfectly inelastic. On the other end of the continuum the product that sells in any quantity but only at or below market price is perfectly elastic.


Price
Demand curve
quantity/Time
Price
quantity/Time
inelastic
elastic

When price ceilings are placed on a product, that is a product can not be sold for more than a designated price, the price is obviously reduced. But, producers are going to be unwilling to supply as much as consumers want to buy. A shortage will occur. Examine the graph on page 6. Fixing prices does not always eliminate the problem of rationing. Buyers and sellers will be willing to make illegal blackmarket deals. If prices or amounts of products supplied are fixed, sellers would loose all incentive on the open market and find buyers elsewhere. The shortage will increase.

Appendix B - Glossary

Demand -- The quantity of a good or service that people want to buy in a given time period, determined by taste, price, personal income, etc. Demand is expressed as a schedule which indicates the quantity demanded of a commodity at various prices during a specific time period.

Elastic demand -- The demand for this type of product is reponsive to change in price. A relative small change in price will cause a relative large change in consumption.

Equilibrium point -- (market price) That point where the demand curve and supply curve intersect on a graphical display. That price where quantity demanded and quantity supplied of an item are equal and business is done.

Inelastic demand -- The demand for this type of product is unresponsive to changes in price. A relative large change in price creates relative small change in consumption.

Supply -- The quantity of a good of service that businessmen, the producers or sellers, want to sell in a given time period. Supply is expressed as a schedule of the quantities supplied at various prices during a specific time period.

The Law of Demand -- There is an inverse (negative) relation between the price of a comodity and the quantity of that commodity demanded.

The Law of Supply -- There is a direct relation between price and quantity supplied. When the price increases, the quantity supplied increases.

III. Appendix C - Suggested Reading (Obtainable in Love Library, University of Nebraska - Lincoln)

Bingham, Robert C.
Economics Concepts: A Programmed Approach
Second Edition, copyright 1966, 1969
McGraw-Hill, Inc.

Gwartney, James D.
Economics, Public and Private Choice
Copyright 1976
Academic Press, Inc.
111 Fifth Avenue
New York, New York, 10003

Hogendorn, Jan S.
Modern Economics: An Introduction
Copyright 1975
Winthrop Publishers, Inc.
17 Dunster Street
Cambridge, Massachusetts 02138

BIBLIOGRAPHY

Asimov, Isaac
World Within Worlds The Story of Nuclear Energy
Volume 1- Atomic Weights Energy Electricity.
U.S. Energy Research and Development Administration
Washington, D.C. 20545

Asimov, Isaac
World Within Worlds The Story of Nuclear Energy
Volume 2-Mass and Energy The Nutron, The Structure of the Nucleus
U.S. Energy Research and Development Administration
Washington, D.C. 20545

Asimov, Isaac
World Within Worlds The Story of Nuclear Energy
Volume 3 - Nuclear Fission - Nuclear Fusion Beyond Fusion
U.S. Energy Research and Development Administration
Washington, D.C. 20545

Corliss, William R.
Space Radiation
U.S. Energy Research and Development Administration
Office of Public Affairs
Washington, D.C. 20545

Eaton, William W.
Energy Storage
U.S. Energy Research and Development Administration
Office of Public Affairs
Washington, D.C. 20545

Eaton, William W.
Oil
U.S. Energy Research and Development Administration.
Office of Public Affairs
Washington, D.C. 20545

Eaton, William W.
Solar Energy
U.S. Energy Research and Development Administration
Office of Public Affairs.
Washington, D.C. 20545

Kaslner, Jacob
Nature Invisible Rays
U.S. Energy Research and Development Administration
Office of Public Affairs
Washington, D.C. 20545

Keisch, Bernard
Atomic Fingerprint: Neutron Activation Analysis
U.S. Energy Research and Development Administration
Office of Public Affairs
Washington, D.C. 20545

Energy From Wind
Energy Research and Development Administration
Office of Public Affairs
Washington, D.C. 20545

Economic Report of the President 1977
Superintendent of Documents
Washington, D.C. 20402

1976 Executive Summary, National Energy Outlook
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

"Nuclear Energy"
Skeptic The Form For Contempory History
Issue number 14
July/August 1976

Water Power, Use of a Renewable Resource
Energy Research and Development Administration
Office of Public Affairs
Washington, D.C. 20545

Slides, Pictures and Tapes

Critical Issues in Science and Society: The Great Energy Debate
Part I and II
Science and Mankind Inc.
White Plains, New York 10603

Television Programs

"Trouble in Coal Country"
NBC Special Report
United Commercial

"Dawn of the Solar Age"
Solar Energy
NOVA

"Incident at Brown's Ferry"
Nuclear Safety Issue
NOVA

"What Price Coal"
Cost of Coal Mining
NOVA

FUTURE ENERGY TECHNOLOGIES

Recommended Level: Junior or Senior High School
Time Required: Five to Seven Days

by
Patrick McGill

Prepared for
The Nebraska Energy Office

FUTURE ENERGY TECHNOLOGIES

ABSTRACT

It is a fact that fossil fuel energy resources are finite. Even with drastic conservation measures they will be totally depleted in the not-too-distant future. Since it was technology that created the tremendous demand and use of fossil fuels, many people look to technology, often unrealistically, to rescue us from the dilemma of dwindling fuel supplies and increasing energy demands.

This unit will examine some of the more promising energy technologies of the future and in so doing attempt to create an awareness of the barriers to be overcome, the possible environmental consequences, and the probable time needed to sufficiently develop these technologies. The end of the unit will attempt to stimulate the student into thinking of even more "far out" energy alternatives and the many factors influenced by their implementation.

RECOMMENDED GRADE LEVEL - Junior High or Senior High

TIME REQUIRED - 5 - 7 days

MAJOR TEACHING STRATEGIES

The simplest strategy to implement would be one of reading/research and class discussion. Diagrams and information sheets are provided for use as masters in making transparencies and/or dittos to aid in the discussions. Another strategy might be to divide the class into groups, with each group taking a different technology, researching it, and then presenting the results to the rest of the class.

MAJOR TEACHING STRATEGIES Continued

For the last part of the unit, one might choose to have a brainstorming session in which students try to come up with new energy alteratives or, after being given a list of future technologies, brainstorm possible environmental consequences.

ESSENTIAL ADVANCE PREPARATIONS

A. Obtain as many resources as possible in the areas of fusion, geothermal energy, fuel cells, solar power satellites, and ocean thermal energy conversion.

B. Obtain classroom sets of the pamphlets or factsheets listed below:

   1. Department of Energy pamphlets - Fuel Cells: A New Kind Of Power Plant; Ocean Thermal Energy Conversion; Geothermal Energy; Fusion

   OR

   2. Department of Energy/NSTA Factsheets - #6. Solar Sea Power; #8. Geothermal Energy; #14. Nuclear Fusion; #16. Energy Storage Technology

C. Prepare transparencies and/or dittos from the masters supplied.

D. Order any films, slides, or video tapes to be used during the unit.

GOALS - The students should:

A. Understand that fossil fuel supplies are finite and rapidly decreasing.

GOALS - Continued

B. Know the theory and problems involved with some proposed future energy alternatives.

C. Analyze various energy alternatives with regard to their possible social and environmental consequences.

D. Realize that many of the well publicized energy alternatives have enormous barriers to overcome and may not be available for large commercial use until well past the year 2000.

E. Envision the possibility of new energy technologies arising from hitherto unthought-of sources.

BEHAVIORAL OBJECTIVES - The student will be able to:

A. Describe the basic fusion process.

B. Name the isotopes of hydrogen being considered for use in fusion reactors.

C. List the three conditions which must be met for fusion to occur in a reactor chamber.

D. Identify realistic proposals of time required for fusion development and commercial use.

E. Identify the three types of geothermal energy systems.

F. Explain what a secondary fluid is and how it may be used in a geothermal power plant.

G. Indicate on a map the general areas of the U.S. which have the most potential as geothermal resources.

H. Name the only geothermal energy production site in the U.S.

I. List at least three possible environmental problems associated with large scale geothermal energy operations.

BEHAVIORAL OBJECTIVES - Continued

J. Explain one method of using ocean temperature differences to produce electrical energy.

K. List at least five problems that need to be dealt with before large scale OTEC plants will become feasible.

L. List three potential advantages of using OTEC power production.

M. Explain how fuel cells differ from ordinary batteries.

N. Draw and label a simple diagram of a fuel cell.

O. Describe the three main components of a fuel cell power system for commercial use.

P. List three attractive features of large-scale fuel cell energy production.

Q. Identify typical dimensions of the scope needed for a solar power satellite.

R. Describe the basic principles of operation of an SPS power system.

S. Explain the advantages of a space-based system as opposed to an earth-based system.

T. List at least three technological problems associated with the development of an SPS system.

U. Identify typical estimates of the cost of an SPS power system.

V. List at least three future energy alternatives other than those studied in detail in this unit (SPS, OTEC, Geothermal, Fuel cells, and Fusion).

W. Describe possible social or environmental effects, given a future energy alternative.

CLASSROOM ACTIVITIES

Day 1 - Introduce the unit by asking the students where our energy comes from. The ultimate source is the sun, but the next step is fossil fuels, nuclear energy, and hydroelectric power. Show the transparency which indicates the percentage of total energy produced by each type of resource. The point is that fossil fuels far outweigh nuclear or hydroelectric production.

Next, discuss with the students how the fossil fuels were formed. (over millions of years). Point out that they are no longer being made! Show the transparency of supply and demand projections to the year 2000. Point out that even under favorable conditions of conservation, economics, and government, the demand for oil and gas will surpass the supply by the year 2000. These facts point to the idea that we must shift to alternative sources of power.

List on the overhead or blackboard, student suggestions of uses for fossil fuels other than the production of power. Alternative power would allow their continued use.

Day 2 - Students read the pamphlets or factsheets on fusion and ocean thermal energy conversion. Follow this with a class discussion of the theory and problems of fusion and OTEC. Use the diagrams provided to make transparencies and dittos which can be used to guide the discussion.

CLASSROOM ACTIVITIES - Continued

Day 2 - While the students are discussing these two alternatives, have them prepare a list of the technological and environmental problems which might occur or which need to be solved before large-scale implementation. You could also do the same with the advantages of the systems.

Show a film on fusion or energy alternatives if available.

Suggest students research other energy alternatives outside of class and report on them.

Have students bring in magazine or newspaper articles on new energy sources.

Day 3 - Hand out the pamphlets on Geothermal energy and fuel cells and the information sheet on solar power satellites. Continue the class discussion as on the previous day. Due to the amount of reading, and if there is reasonable class discussion, this activity will probably carry over to the next day.

Day 4 - After finishing the discussion from day 3, have the class pool thier lists of technological and environmental problems. Then hand out the prepared information on the problems with these energy alternatives and compare them with the students' list. See if they can come up with others.

CLASSROOM ACTIVITIES - Continued

Day 4 - As a good review, you might want to conduct a debate the following day on which of the energy alternatives discussed would be the "best". If so, this would be a good time to divide the class into groups to prepare their strategy.

Day 5 - As an alternative to having a debate, the teacher may want to discuss the implications of the indirect technologies sheet which is provided. Probe the students' attitudes on audio/video communicators, laser powered aircraft, and a satellite-lit night sky. Have them brainstorm other energy alternatives or conservation methods. Have them analyze the above suggestions for possible environmental implications.

Encourage interested students to draw their conception of large communication satellites, laser powered aircraft, people powered vehicles, flywheel powered vehicles, solar power satellites, etc.

Day 6 - Evaluation (if desired)

EVALUATION SUGGESTIONS

If a final test over the unit is desired, it is suggested that the questions be constructed from the behavioral objectives. A daily evaluation might be based upon the student's participation in the class discussion. Of course, extra credit could be given to those who brought in articles, drawings, or reports.

EVALUATION SUGGESTIONS - Continued

It might be worthwhile to construct the final test ahead of the unit presentation and use it as a pretest to determine the students' entering level and where the most emphasis should be placed.

RESOURCES

A. Pamphlets and Factsheets - Classroom sets

1. Pamphlets
    - a. Ocean Thermal Energy Conversion
    - b. Fuel Cells: A New Kind Of Power Plant
    - c. Geothermal Energy
    - d. Fusion
2. Factsheets
    - a. #6. Solar Sea Power - Ocean Thermal Energy Conversion
    - b. #8. Geothermal energy
    - c. #14. Nuclear Fusion
    - d. #16. Energy Storage Technology

Available from:

Nebraska State Energy Office
4 th floor, 301 South Centennial Mall
P.O. Box 95085
Lincoln, NE 68509

OR

(SEE NEXT PAGE)

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RESOURCES - Continued

DOE-Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

B. Booklets

1. *Oil* by William W.Eaton
2. *Controlled Nuclear Fusion* by Samuel Glasstone
3. *Worlds Within Worlds: The Story Of Nuclear Energy Vol. 3* by Isaac Asimov

Available from the Department of Energy Technical Information Center [illegible]s above)

OR

Nebraska State Energy Office

C. Films

1. Department Of Energy Film Library- Technical information Center
   P.O. Box 62
   Oak Ridge, Tennessee 37830
   - a. General
     1. 0508 Challenge of the Future (1975) 29 min.
     2. 0503 When The Circuit Breaks (1975) 27 ½ min.
   - b. Fusion
     1. 0488 To Bottle The Sun (1973) 5½ min.
     2. 0474 To Imitate The Sun (1971) 33 min.
     3. 0509 The Ultimate Fire (1976) 28 min.

RESOURCES - Continued

4. 0484 A Superconducting Magnet For Fusion Research (1971) 22 min.

c. Geothermal

1. 0501 Power From The Earth (1974) 12½ min.
2. 0519 Geothermal- Nature's Boiler (1977) 25 min.

2. Lincoln Public Schools- Instructional Media Center

a. General

1. 1134-14 Energy:New Sources 20 min.
2. 1220-14 Energy For The Future 17 min.

b. Fusion

1. 1957-14 Fusion- The Ultimate Fire 14 min.

3. Nebraska Library Commission (request from local libraries)
1420 P Street
Lincoln, NE 68508

a. General

1. 0275 Energy To Burn (1970) 20 min.

D. Filmstrips/Sound

1. Nebraska Library Commission (request from local libraries)

a. General

1. Energy For The Future 14 min, casette
2. Energy In The Earth 14 min. casette
3. Fossil Fuels 14 min. casette

4. Nuclear Power 14 min. casette

5. Using Energy 14 min. casette

SUPPLEMENT

A. Additional Resources

1. Books

   a. *Energy: Global Prospects 1985 - 2000* by the Workshop on Alternative Energy Strategies, McGraw Hill Book CO., 1221 Avenue of the Americas, New York, NY 10020, 291 pages, 1977

2. Booklets

   a. *Western Energy Resources and The Environment: Geothermal Energy*, Environmental Protection Agency Office of Research and Development, Office of Energy, Materials, and Industry, Washington, D.C., 20460, 203 pages Apr. 1977

   b. *Geothermal Energy* by William W. Eaton, U.S. Department of Energy Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830 42 pages, 1975

3. Pamphlets

   a. *Energy in Focus*: Basic Data, U.S. Dept. of Energy Technical Information Center, P.O, Box 62, Oak Ridge, Tennessee, 37830, 13 pages, Jan. 1978

4. Magazines

   a. The Journal of Aerospace Education, April,1978 pp.8-10

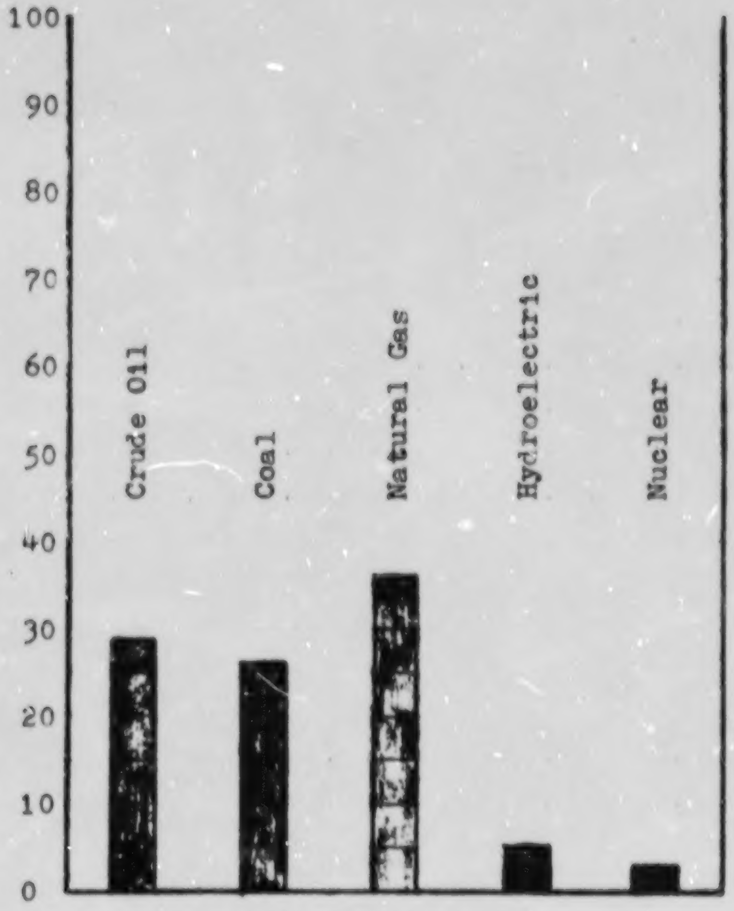
   b. Aerospace , (official publication of the aerospace industries association), summer 1978 pp. 2-6

B. Charts , Diagrams, and Information Sheets - SEE FOLLOWING PAGES

FUEL USE

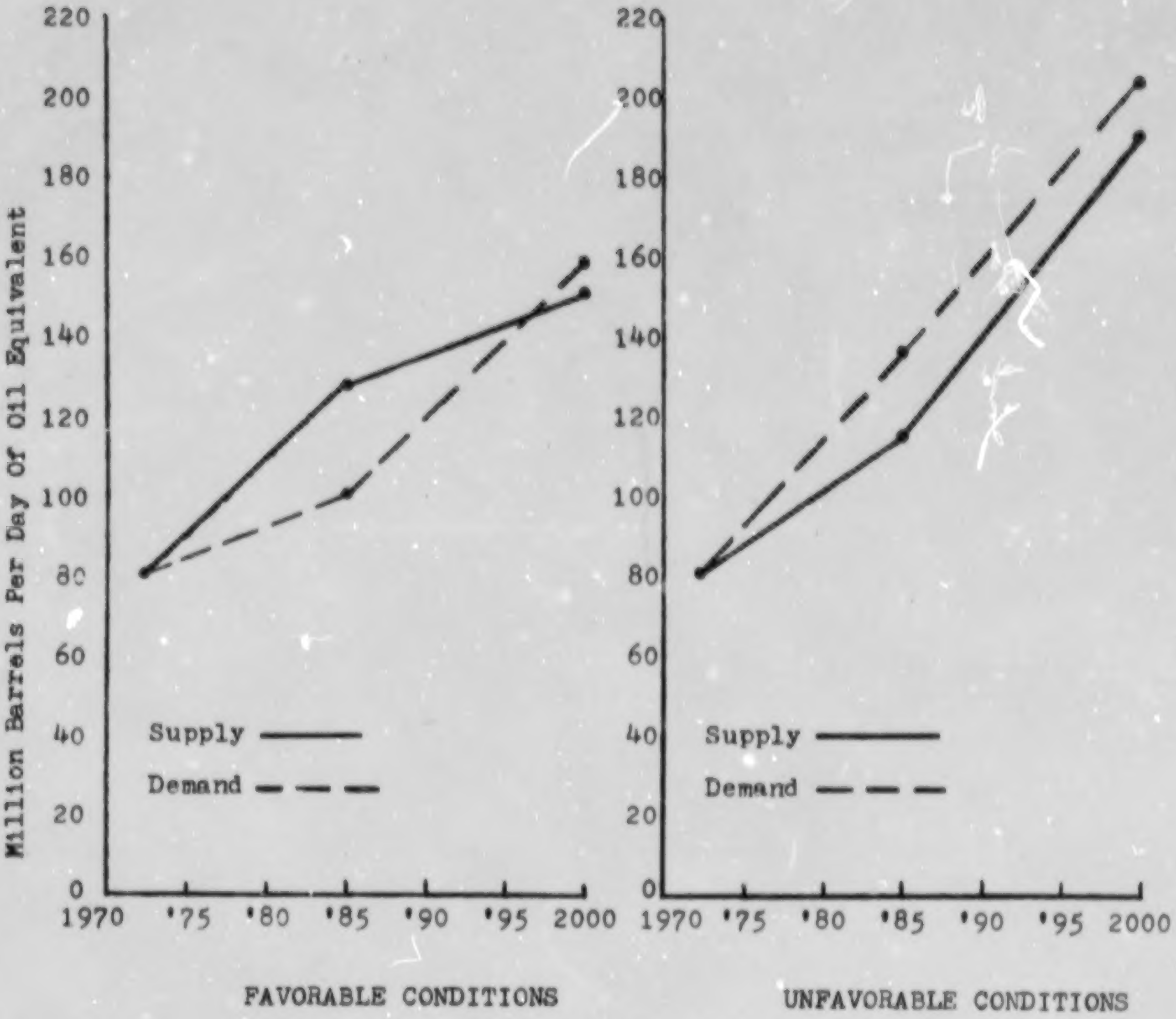
PERCENT OF TOTAL DOMESTIC ENERGY PRODUCTION

(1976)



PROJECTED

TOTAL ENERGY SUPPLIES AND DEMAND*



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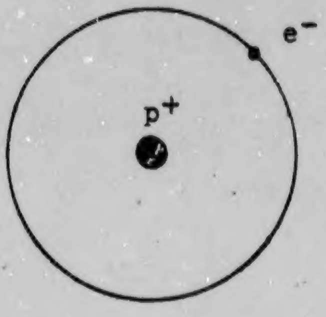
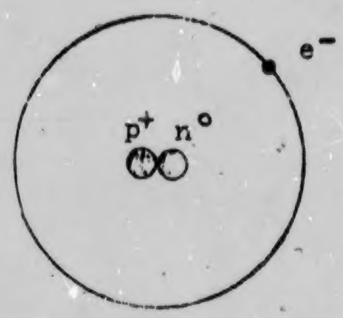
*Based on information contained in Energy: Global Prospects 1985 - 2000.

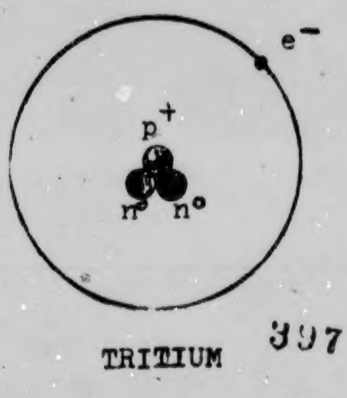
HYDROGEN AND ITS ISOTOPES



HYDROGEN

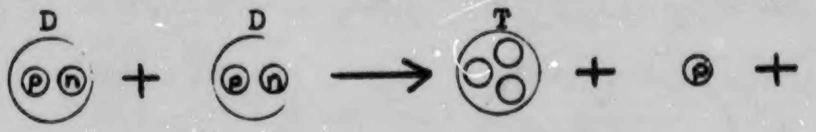


DEUTERIUM

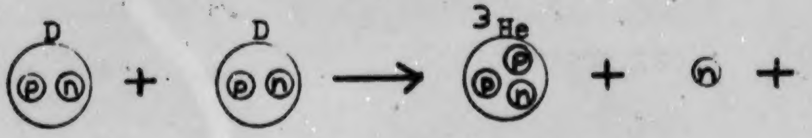


TRITIUM

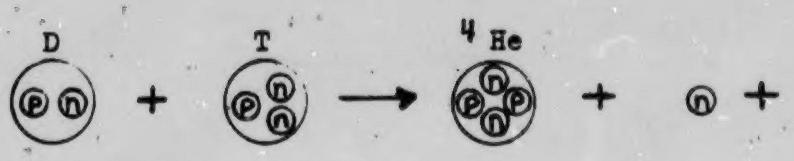
TYPICAL FUSION REACTIONS



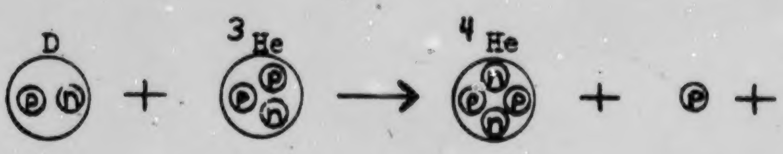
3.3 Mev (75 M Btu/gm.)


D
p n
+
D
p n
3He
p p n
+
n
+

4.0 Mev (92 M Btu/gm.)

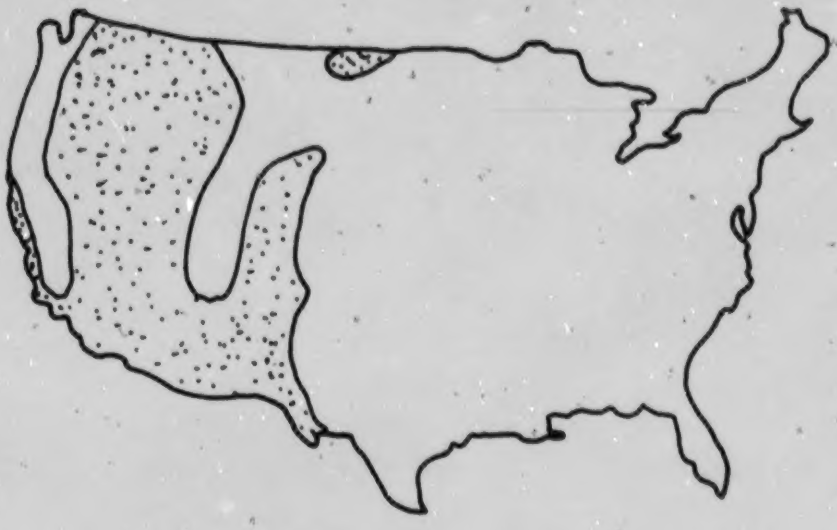

D
p n
+
T
p n n
4 He
n p p n
+
n
+

17.6 Mev (313 M Btu/gm.)


D
p n
+
3 He
p p n
4 He
n p p n
+
p
+

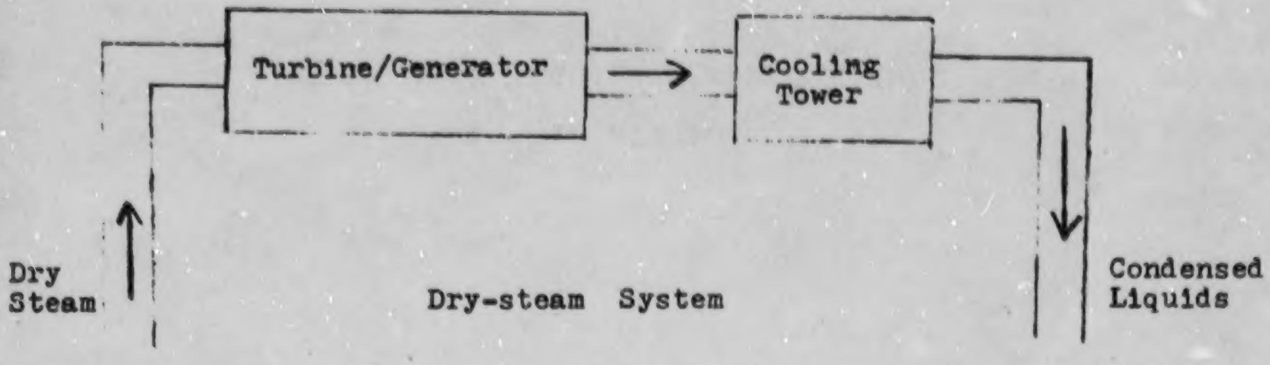
18.3 Mev (334 M Btu/gm.)

GENERAL DISTRIBUTION OF HOT CRUSTAL AREAS IN THE UNITED STATES

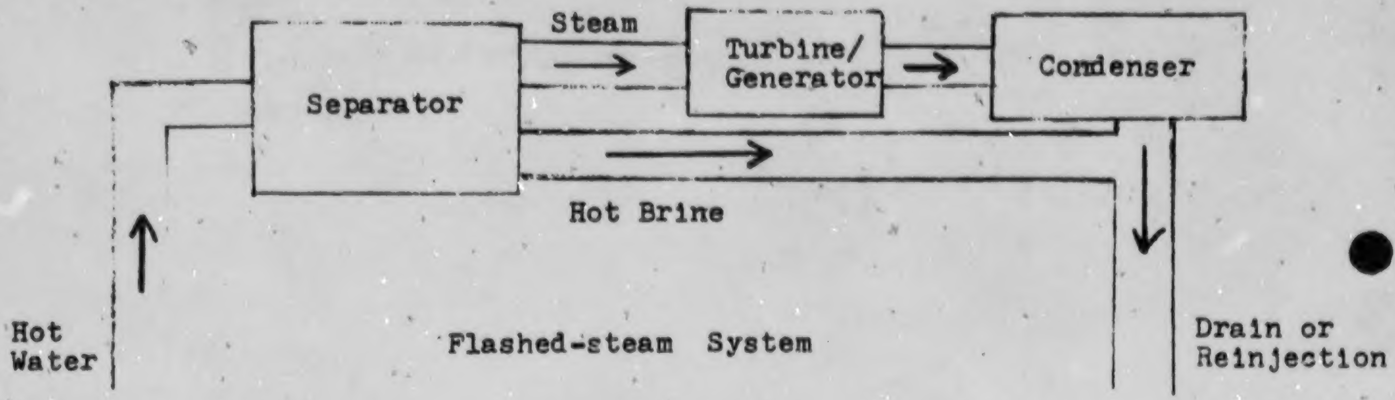


309

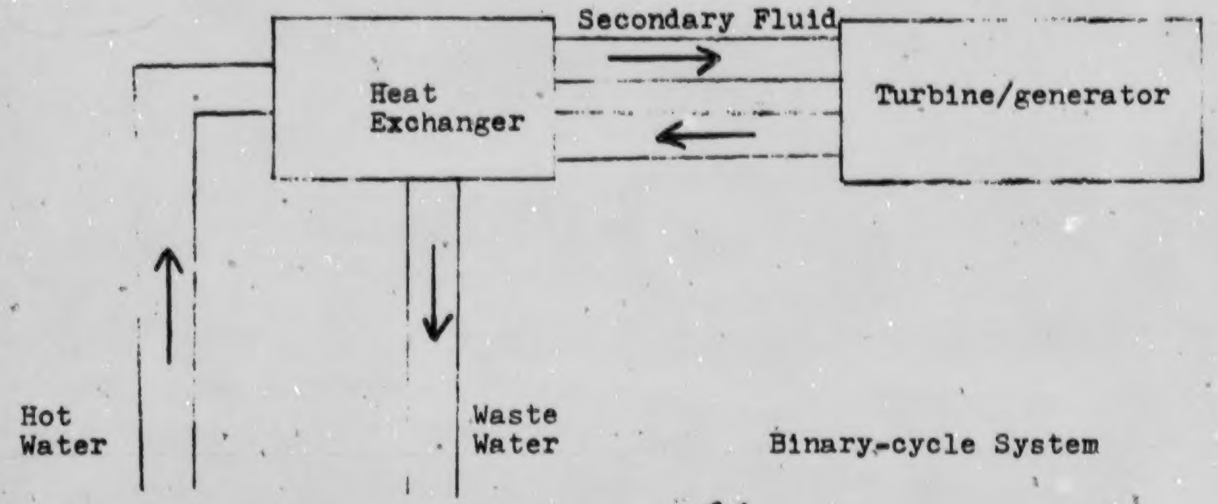
HYDROTHERMAL CONVECTION SYSTEMS


Turbine/Generator
Cooling Tower
Dry Steam
Condensed Liquids

Dry-steam System

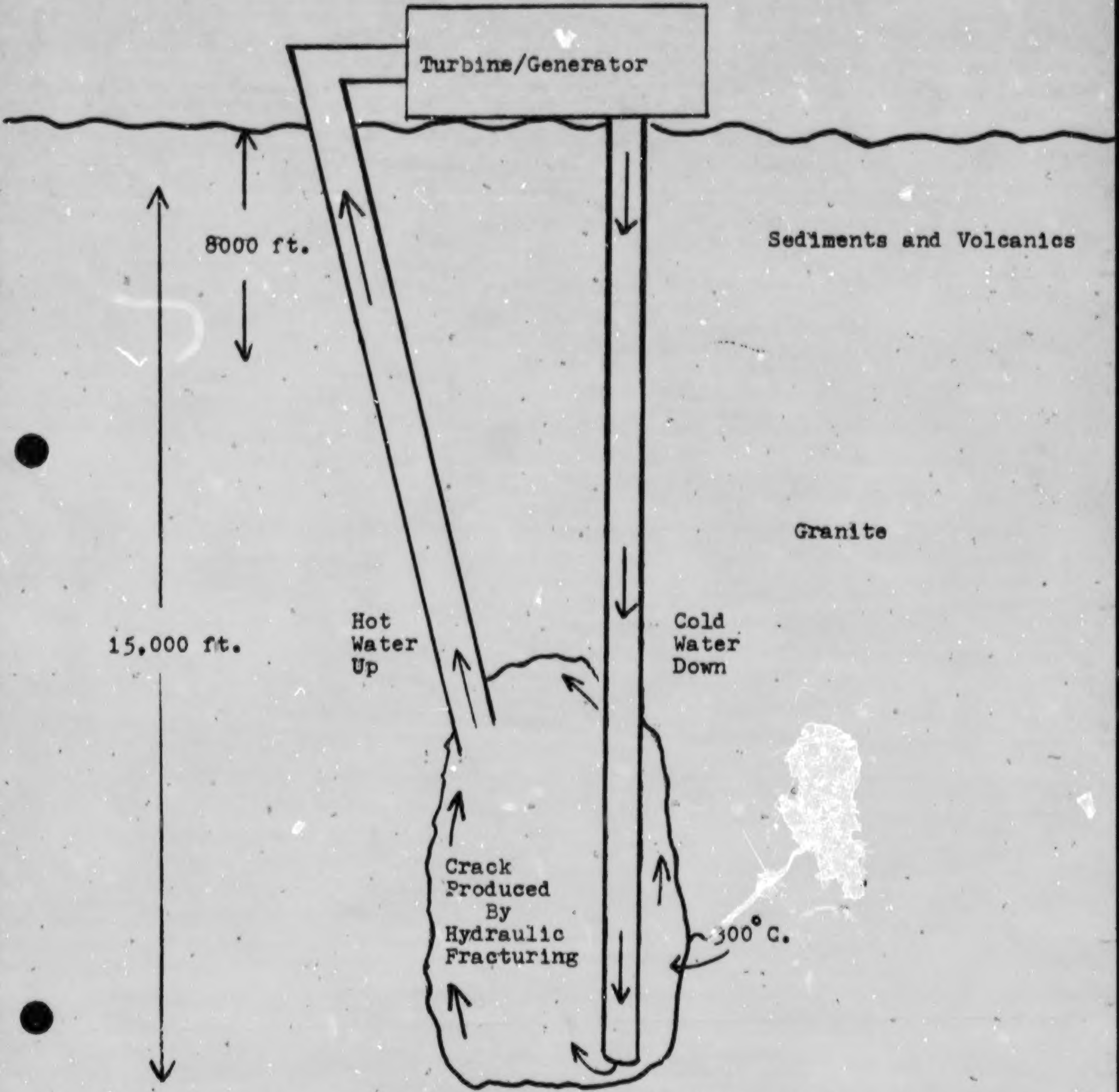

Steam
Separator
Turbine/ Generator
Condenser
Hot Brine
Hot Water
Drain or Reinjection

Flashed-steam System


Secondary Fluid
Heat Exchanger
Turbine/generator
Hot Water
Waste Water

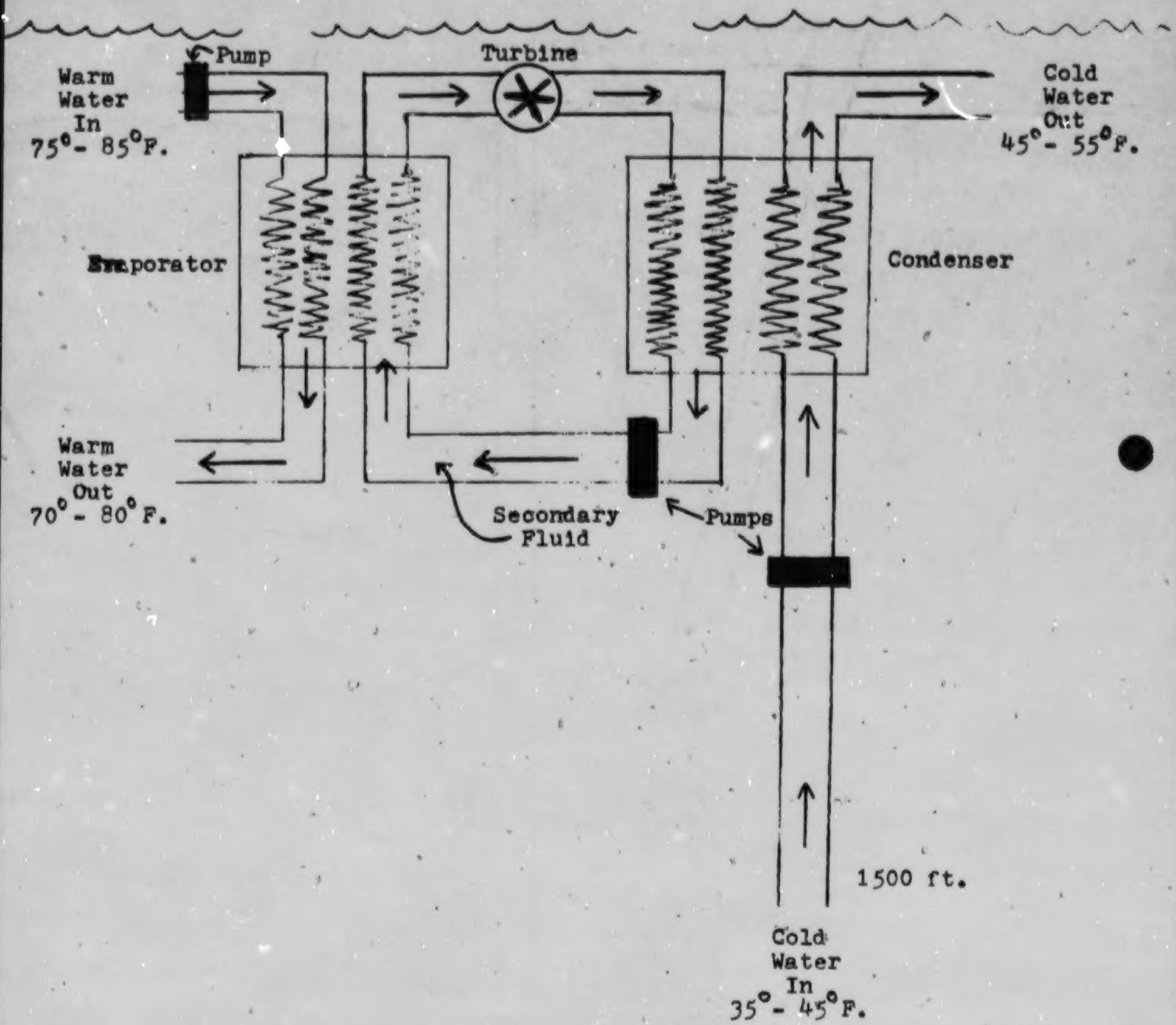
Binary-cycle System

HOT IGNEOUS SYSTEMS


Turbine/Generator
8000 ft.
15,000 ft.
Sediments and Volcanics
Granite
Hot Water Up
Cold Water Down
Crack Produced By Hydraulic Fracturing
300° C.

OCEAN THERMAL ENERGY CONVERSION

(OTEC)


Pump
Warm Water In 75° - 85° F.
Turbine
Cold Water Out 45° - 55° F.
Evaporator
Condenser
Warm Water Out 70° - 80° F.
Secondary Fluid
Pumps
1500 ft.
Cold Water In 35° - 45° F.

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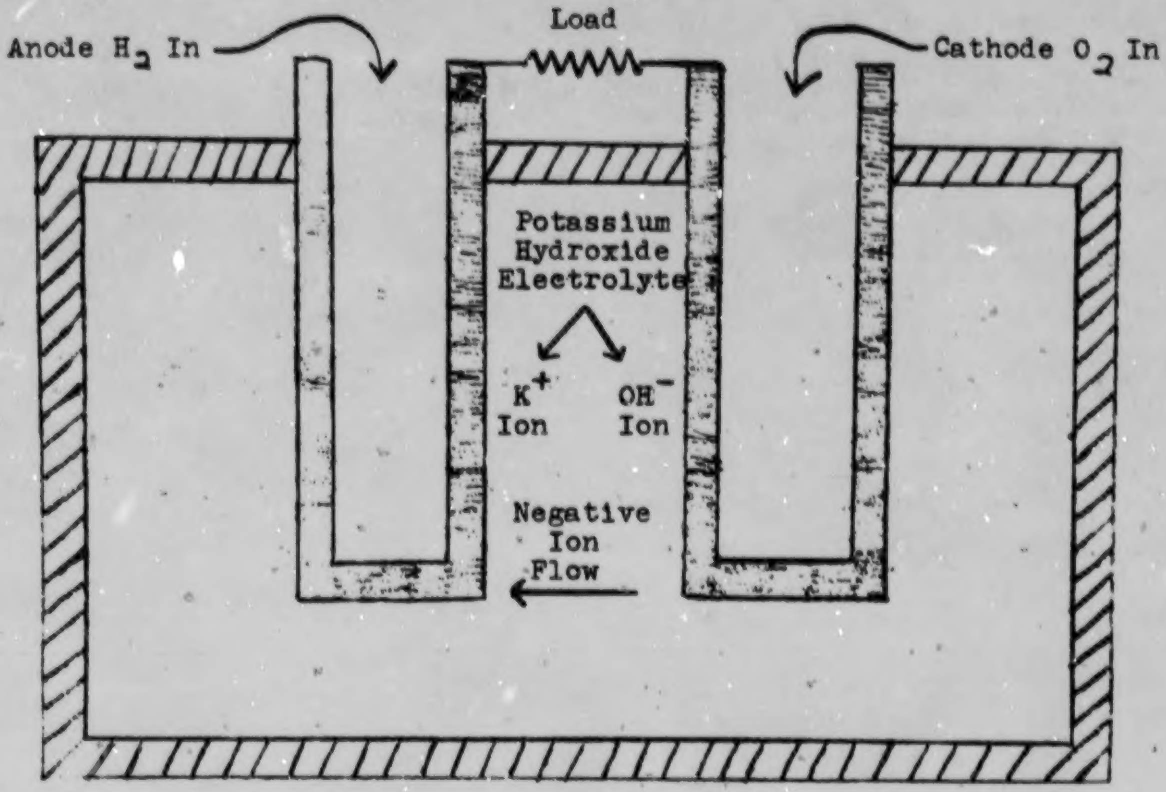
OXYGEN - HYDROGEN FUEL CELL


Anode H_2 In
Load
Cathode O_2 In
Potassium Hydroxide Electrolyte
K^+ Ion
OH^- Ion
Negative Ion Flow

40ɜ

SOLAR POWER SATELLITE (SPS)

INFORMATION SHEET

The solar power satellite (SPS) is one of the alternative energy sources being proposed for the future. The basic idea is to build several very large (3 mi. x 15 mi.) satellites which would orbit the earth in a synchronous orbit (22,300 mi. high), collect energy from the sun, and beam this energy down to earth in the form of microwaves. On earth, a large (5-6 mi. dia.) rectifier antenna or 'rectenna' would receive the microwaves and convert them to usable power.

Proponents of the system give several advantages of the SPS system. There is 15 times more solar energy available in space than on the ground and the SPS would be exposed to the sun 99% of the time, unlike earth-based systems. There would be no waste heat or toxic products added to our environment, and the SPS would not, of course, use up any fossil fuels. Each SPS might have a potential for producing up to 10,000 megawatts and some estimates show that 45 of these satellites would match the current electrical energy needs of the U.S.

Development of this system, of course, will depend upon the operation of the Space Shuttle program. The Shuttle would be responsible for taking large work crews into space safely. The transporting of the enormous amounts of raw materials to space will require a larger transport vehicle than the Shuttle. Once in space, the work crews would also need living and work areas. Since the Shuttle is a relatively low altitude vehicle, the SPS would have to be assembled in low orbit and then pushed to a higher orbit.

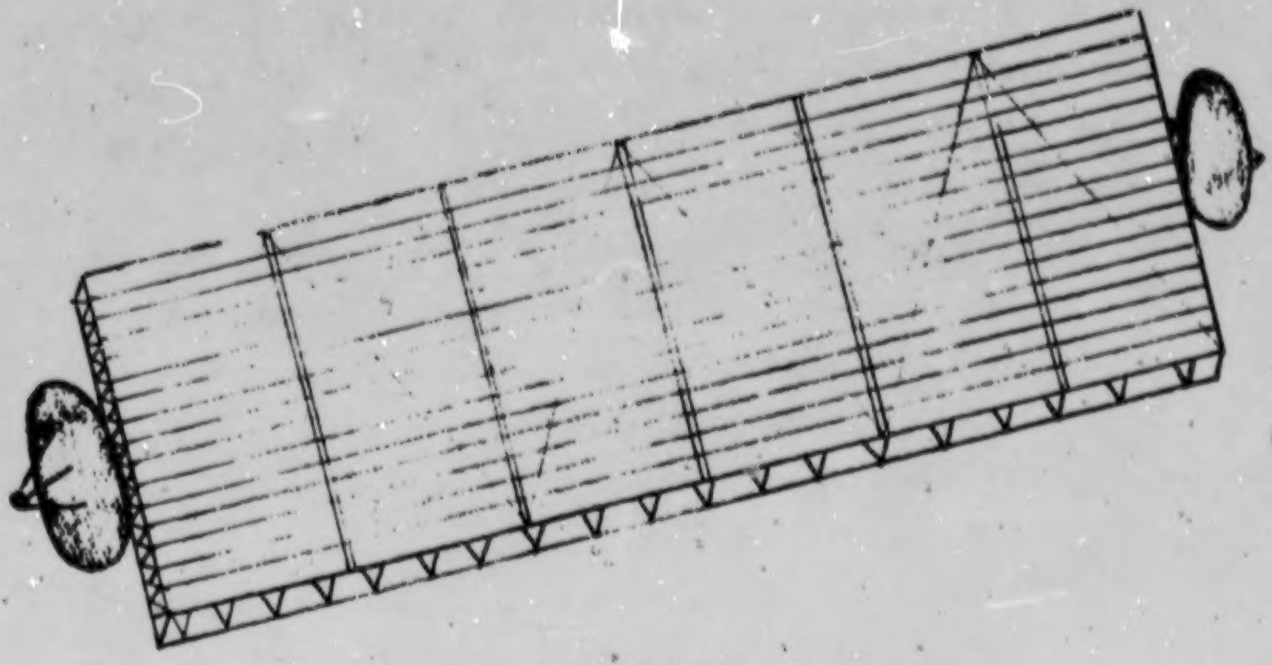
The satellite itself could collect the sun's energy through the use of solar cells (photovoltaic cells) or by using the sun's heat to vaporize a fluid which would turn a turbine and generator. Solar cells appear to be less complicated, but development needs to continue to make them more efficient and to reduce the cost of manufacturing the billions of cells that would be required.

One major objection to the SPS system is the possible harmful effects Of the microwave beam to animals and humans. Proponents say the microwave levels outside the antenna area or under it would be below the current U.S. safety standards. Even flying directly through the beam would have very little effect on living things. Another objection to the microwave system is the large antenna required to receive the energy. It has been suggested that these could be built offshore, or on unused land, or even suspended above pasture or farmland.

The cost of anSPS system would obviously be very great, but some groups say it would be well worth it to our country. One estimate of the cost is 40 to 80 billion dollars spread out over 17 years. This seems like a lot until one understands that the U.S. spent 123 billion dollars for energy in 1976 alone! If the money is funded and if the technological problems can be overcome, it is projected that initial SPS operation could begin in the 1990's and by 2000 be contributing almost half of our current electrical energy consumption.

SOLAR POWER SATELLITE

(SPS)

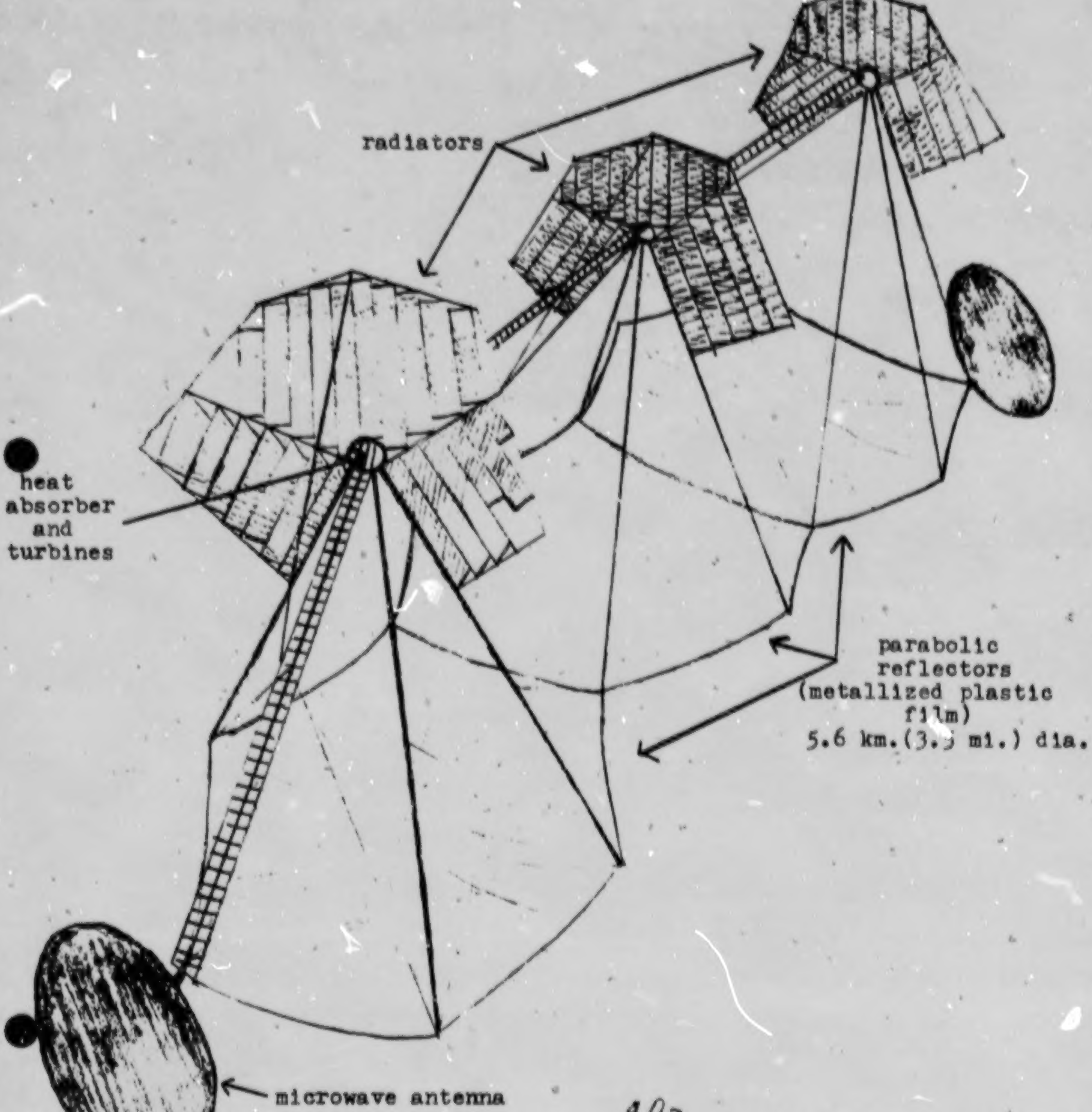


5 km. (3.1 mi.) WIDE

25 km. (15.6 mi.) LONG

14 BILLION SOLAR CELLS

SOLAR FURNACE ARRAY


radiators
heat absorber and turbines
parabolic reflectors (metallized plastic film) 5.6 km. (3.5 mi.) dia.
microwave antenna

PROBLEMS WITH ENERGY ALTERNATIVES

1. FUSION

   A. How to get it hot enough (100,000,000 °C.), dense enough, and contain it long enough.

   B. Radioactivity produced in the reactor materials.

   C. Removal of fuels from the ocean?

   D. ______________________________

   E. ______________________________

2. OCEAN THERMAL ENERGY CONVERSION

   A. Change in ocean temperature distributions.

   B. Change the ecological balance due to cold, nutrient rich water being pumped to the surface.

   C. Corrosion of pipes and equipment.

   D. Release of carbon dioxide from the cold water as it is heated.

   E. Stability of plants in rough seas.

   F. Clogging of heat exchangers and other equipment with marine organisms.

3. GEOTHERMAL ENERGY

   A. Drilling deep enough.

   B. Distribution of near-surface geothermal sources.

   C. Pollution from water and steam impurities.

   D. Subsidence caused by water or steam removal.

   E. Earthquakes caused by large scale reinjection of used water.

   F. Noise

   G. Hydrogen sulfide odor.

   H. Large land areas are required.

I. Pumping equipment for deep wells.

J. ____

K. ____

4. FUEL CELLS

A. Reliability and durability

B. Obtain hydrogen from fossil fuels.

C. ____

D. ____

5. SOLAR POWER SATELLITES

A. Safe facilities for large work crews in space.

B. Large transport vehicles for raw materials.

C. Techniques for constructing large structures in space need to be developed.

D. More efficient, reliable solar cells.

E. Maintenance

F. Ground antenna

G. Heat electrons in the upper atmosphere?

H. Danger from the microwave beam?

I. ____

J. ____

INDIRECT ENERGY TECHNOLOGIES

A. Communications Systems

1. The development of very large communications satellites would allow small receivers on earth (the opposite of the current situation). These large satellites could handle many small transmitting and receiving beams, allowing personal audio-video communications. This personal communication would obviate the need for many business personnel to locate in one large building (such as in many local insurance companies).
2. Implications - If it could cut commuter travel by only 15 percent, it would result in saving millions of gallons of oil per year by the year 2000. Also, pollution would be decreased, there would be fewer vehicle accidents, lower insurance rates, less time lost on the job due to accidents, etc.

B. Projection of Light From Space

1. Large, metallized plastic film reflector satellites could be orbited to direct light at various points on earth. Brightness would be on the order of 10 - 100 moons(the sun is 1,000,000 moons).
2. Implications - They could be used for urban lighting, thus reducing the need for street lights, lighted signs, etc. They could provide more light to ground-based solar installations for increased efficiency. Large light and heat reflectors could provide for agricultural and climate control needs.

C. Laser Powered Aircraft

1. Large, 50 megawatt CO_2 (or other type) lasers could be orbited and selectively directed at aircraft flying at 30,00 - 35,000 feet to propel them at near the speed of sound.
2. Implications - No fossil fuels would be needed except when taking off and landing. Also less pollution of the upper atmosphere layers.

* These ideas were taken from a speech by Dr. Krafft Ehricke of the Space Global Cómpany, presented at the 1978 National Congress on Aerospace Education.

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OTHER ENERGY ALTERNATIVES
FOR DISCUSSION

A. Flywheel Power

B. Batteries

C. Magnetic Energy Storage

D. Magnetohydrodynamics (MHD)

E. Matter-Antimatter Reactions

F. Hydrogen Fuel

G. Breeder Reactors

H. People Power

I. Thermal Energy Storage

J. ______________________________

K. ______________________________

L. ______________________________

ENERGY USES IN NEBRASKA AGRICULTURE

Grade Level: Grades 9-12
Recommended Subject Areas: Social Studies, Science, Vocational Agriculture
Time Requirement: Approximately 12 class periods

by
Darrol Gray, Shelby High School
Dennis Gray, Hordville High School
Jerry Beach, Bradshaw High School

Prepared for
The Nebraska Energy Office

ABSTRACT** ENERGY USES IN AGRICULTURE

The modern farmer is faced with the problems of decreasing energy supplies and increasing energy costs. At the same time, there is a call for increased production. The farmer depends on energy for his livelihood. His irrigation systems are run by natural gas and his fertilizer is derived from natural gas. Diesel fuel and gas power his tractors, combines and trucks. The amount of energy consumed in agriculture is overwhelming. Annually, the farms in America use:

1.5 billion gallons of L.P. gas
6.3 billion gallons of gasoline and diesel fuel
32.3 billion kilowatt hours of electricity
173 billion cubic feet of natural gas

The figures seem large, yet they represent only about 3% of the United States total energy budget. This is the energy required for the production of the food. At-home food preparation requires more than 4% of the United States energy budget, thus food preparation requires more energy than food production.

According to Dr. William Scheller, University of Nebraska-Lincoln chemical engineer, agriculture produces a net gain in energy. The corn produced on Nebraska farms generates approximately four and one-half times as much energy as is used in its production.

This unit will deal with three major areas of energy consumption in agriculture and offer alternatives or energy-saving suggestions in each area. The three topics to be covered are machine operations, irrigation and chemicals.

Teacher Preparation Recommendations

Recommended Grade Levels- 9 through 12, Social Studies, Science, Vocational Agriculture.

Time Required About 12 days

Major Teaching Strategies-Class and group discussions, role-playing, observation, attitude clarification, and inquiry.

Essential Advance Preparation- Obtain materials in the bibliography from your local County Extension Agent. Obtain a map of center-pivot irrigation systems in Nebraska. (Available from Dr. Marvin Carlson, Nebraska Hall, University of Nebraska-Lincoln, Lincoln, Nebraska. Cost: $1.50 per map) Obtain as many 1-gallon metal cans as you can from the school, printing shops or office supply company. Start Section III-Activity II-part I at the beginning of the semester. Make arrangements for a speaker and/or a field trip.

Suggested Daily Lesson Plan

Day 1	Administer pre-test. Give an introduction to the unit. Have student find as many 1-gallon metal cans as they can. Have students do Section III-Activity II-part 2.
Day 2	Give introduction to Section I: Machine Operation. Discuss Activity I. Have students paint cans to dry overnight.
Day 3	Discuss Activity II. Proceed with Activity III.
Day 4	Introduce Section II: Irrigation. Give statistics handout for student reference and discuss briefly. Introduce and discuss Activity I. Give students last few minutes of class time to finish Activity III of Section I, empty cans and put away.
Day 5	Discuss Activity III of Section I. Have students make their own conclusions. (About 10 minutes). Introduce speaker. (See suggested activities).
Day 6	Field trip
Day 7	Introduce Section III: Chemicals. Give charts and quesitons in Activity I as a handout. Complete the activity by breaking up into groups of about 5 students each for 20 to 30 minutes.
Day 8	Discuss and finish Activity I. Compare groups answers. Let Students make their own conclusions. Have students make final observations of their beet or radish seedlings. Discuss results. Let plants continue to grow if you need them or dispose of them.
Day 9	Introduce and discuss Activity III. Prepare students for activity IV by assigning groups and giving situation.
Day 10	Meet in library
Day 11	Give a brief presentation on herbicides. Finish activity IV
Day 12	Evaluation day. Give Post-test.

PRETEST

Read the statements and place a check in the blank which best describes your attitude toward the statement.

SA - Strongly Agree
A - Agree
N - No Opinion or don't know
D - Disagree
SD - Strongly Disagree

	SD	D	N	A	SA
1. America could grow as many crops as are presently grown with much less energy.	___	___	___	___	___
2. The prices a farmer gets for his goods does not effect the people in the large city.	___	___	___	___	___
3. The more fertilizer applied to land, the better the crop yield.	___	___	___	___	___
4. Farms use more energy than any other sector of our society.	___	___	___	___	___
5. Americans can save energy by being selective in the food they buy.	___	___	___	___	___
6. If proper cultivation is used, herbicide use can be reduced.	___	___	___	___	___
7. A high meat diet is more effective in terms of energy use than a diet of mostly vegetables.	___	___	___	___	___
8. The larger the farm, the more efficient the farm.	___	___	___	___	___
9. Irrigation creates more problems than benefits.	___	___	___	___	___
10. The government should not control pesticides that are absolutely necessary.	___	___	___	___	___

POSTTEST

Read the statements and place a check in the blank which best describes your attitude toward the statement.

SA - Strongly Agree
A - Agree
N - No opinion or don't know
D - Disagree
SD - Strongly Disagree

	SD	D	N	A	SA
1. Greater amounts of energy will be needed in the future to maintain our present level of farming.					
2. The economy of the city is directly tied to the agriculture economy.					
3. There is a limit where more fertilizer application no longer increases yields.					
4. Agriculture uses only a small percentage of the total U.S. energy budget.					
5. Most food products require about the same amount of energy to produce.					
6. Herbicides are necessary to keep the field clean.					
7. Vegetables have a higher energy return than meat.					
8. Farm efficiency depends on good planning and management.					
9. Benefits from irrigation far outweigh the problems created.					
10. Government control of pesticides is needed for the safety of citizens.					

Pretest-Posttest Information

These tests are set up to determine if any change in attitude occurred. An agree on the pretest corresponds to a disagree on the posttest. To see if a change in attitude occurred compare the answer on each question of the pretest to the corresponding numbered question on the posttest.

Ex. If question 1 on the pretest is answered as disagree and question 1 on posttest is answered agree, no attitude change has occurred.

If both are answered as agree then a change in attitude occurred.

If a no opinion has been changed, this will at least show an awareness of the problem.

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SECTION I

TITLE: MACHINE OPERATION

Introduction:

Agricultural land used primarily for crops, pastures or grazing accounted for slightly over 94 percent of Nebraska's 49 million acres, of land in 1977. Described as the proportion of the state's land in farms, this figure has remained very stable over time.

Current projections have set Nebraska's cropland figures at nearly 23.6 million acres (Fischbach, 1977) with the need for getting more work per gallon of fuel being a critical factor. Some of the possibilities that do exist for improvement of fuel efficiency are tractor operation, cropping methods and fuel storage.

Only 3 percent of the United State's total energy budget is used for on the farm agricultural purposes. However, each Nebraska farmer, on the average, has access to enough energy to produce food for himself and approximately 45 other people (Lane, 1973). One of the major uses of this energy is in the operation of farm equipment.

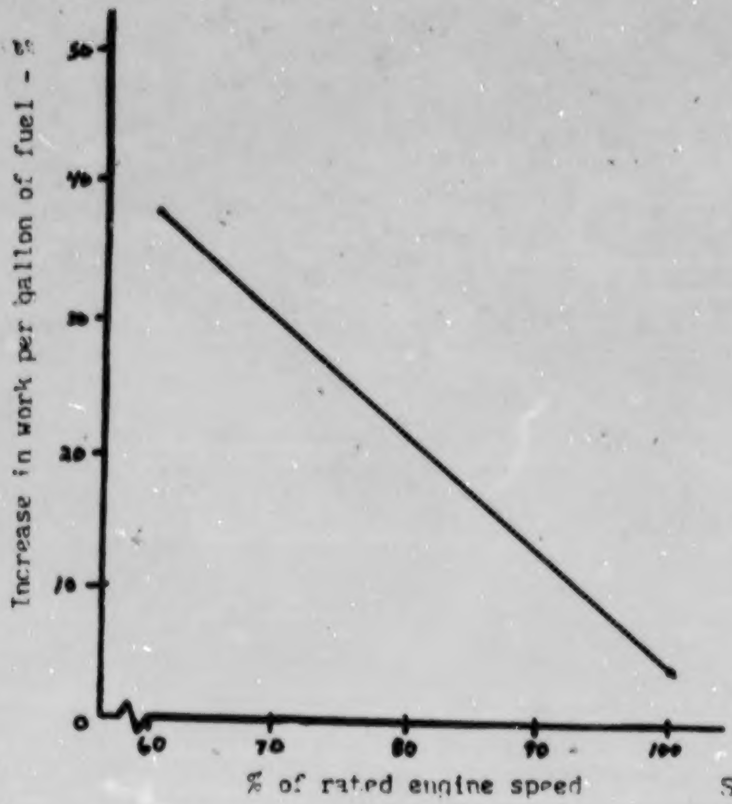
Behavioral Objectives-Machine Operation

The student will be able to:

(A) determine the proper engine speed for maximum fuel efficiency of a tractor.
(B) describe proper maintance and care of farm equipment for efficient use of fuel.
(C) determine which cropping methods use the [illegible]st energy.
(D) determine which cropping methods use the least amount of energy.
(E) compare cropping methods in regard to energy use.
(F) determine the effects of different colors of paint on fuel storage containers.
(G) demonstrate different methods for efficiently storing fuel.

ACTIVITY I: TRACTOR EFFICIENCY

CHART OF EFFECTIVE ENGINE SPEED ON TRACTOR EFFICIENCY



Source: Lane, 1973

Questions:

1. At what percent of rated engine speed should a tractor be run to reach the maximum efficiency?

2. Beside a decrease in efficiency, what are other reasons a tractor should not be run at 100% or near 100% rated engine speed?

3. What might be the effect on the efficiency of a tractor if it does not receive the proper maintenance and care?

Conservation Methods - Tractor Efficiency

Many tractors could do more work if they are properly maintained. A regular check of the following maintance items will keep the tractor operating at peak efficiency: (1) governor operation, (2) air cleaner, air precleaner, and air cleaner stack, (3) ignition timing, (4) ignition points, condenser, and points, (5) wiring, (6) spark plugs, (7) fuel filters and carburetor, (8) fuel mixtures. On diesel engines the pump and injectors require special tools and procedures and therefore should be serviced by a trained technician. The tractor operator can reduce diesel injector troubles by keeping fuels and lubricants clean and free of dirt and water.

Activity II: Cropping Methods

This table contains estimates for the average quantity of gasoline or diesel fuel required for most field operations used to produce corn and soybeans. The figures include only the fuel required for actual field work; no allowance is included for machine preparation or travel to and from the field.

Energy Requirements--Field Operations (gallons per acre)

Field operation	Fuel type	
	Gasoline	Diesel
TILLAGE		
Shredding cornstalks	0.90	0.60
Moldboard plow	2.70	1.90
Chisel plow	1.70	1.20
Offset disk	1.35	0.95
Powered rotary tiller	2.30	1.60
Tandem disk, plowed field	0.95	0.65
Tandem disk, tilled field	0.80	0.55
Tandem disk, cornstalks	0.65	0.45
Field cultivate, plowed field	1.15	0.80
Field cultivate, tilled field	1.05	0.75
Spring-tooth harrow, plowed field	0.70	0.50
Spring-tooth harrow, tilled field	0.65	0.45
Peg-tooth harrow, tilled field	0.25	0.15
PLANTING (30-inch rows)		
Planter only, tilled seedbed	0.45	0.30
Planter w/fert. and pesticide attach., tilled bed	0.70	0.50
Till-planter (sweep)	0.60	0.40
No-till planter (fluted coulter)	0.50	0.35
Harrow-plant combination	1.15	0.80
Rotary strip-till plant	1.50	1.05
Grain drill	0.50	0.35
HARVESTING		
Combine, soybeans	1.70	1.10
Combine, corn	2.35	1.60
Corn picker	1.75	1.15

Source: Iowa State University

Questions:

1. If in getting a field ready, planting and harvesting a crop a farmer, (1) moldboard plows, (2) tandem disks the plowed field, (3) harrows (spring tooth), (4) plants w/fert. and pest. attach, (5) cultivates (plowed field), and then (6) combines the corn, how much fuel (gas and/or diesel) will be used per acre?

2. If gas sells for 60.5¢/gal and diesel 45¢/gal, what would be the dollar investment of fuels in question one?

3. What is minimum tillage farming? What effect does this have on energy consumption in field operations?

Alternatives and Conservation measures- Cropping methods

Most Nebraska farmers use some form of minimum tillage. Minimum tillage is used in many forms including single pass operations such as the till planter, and other forms such as disking and planting, disking and listing, or shredding, disking, and planting. The plow, a high consumer of energy, is eliminated with minimum tillage. Although, most methods of raising crops in Nebraska include some form of minimum tillage, such as disking and planting, disking and listing, till plant and slot plant could make field time even more effective. Slot planting or till planting methods require the least fuel of all the common cropping methods and uses only three operations; planting, spraying, and harvesting.

For the best possible use of fuel, farmers should eliminate any unnecessary field operations, eliminate unnecessary travel, eliminate engine idle time and choose operations that have lower energy requirements.

Activity III: Fuel Storage

As fuel supplies become scarcer and costs continue to rise we need to consider various practices which can reduce the amount of energy now being wasted. One you might overlook when thinking of wasted fuel and energy is fuel storage. The losses from one gasoline storage tank may cost you more than $75 per year.

Laboratory Exercise: Expansion of liquids

Purpose - To demonstrate heat gain and expansion of liquids stored in different colored containers.

Materials needed - 2 - 1 gallon metal cans with lids (Spirit master fluid cans work good)

red paint (flat red)

White paint (flat white)

Procedure - Paint one of the cans with the flat read paint and the other with the white paint. When the paint is dry, take a small, sharp nail and make a hole in the top of the can in the corner opposite the lid. Then fill the containers completely full of water and put on the lid tightly. Place these containers where the sun will shine directly on them for several hours (or until the next class meeting). Observe and record the results of any changes that you may see that have happened.

Questions - 1. What happened to the water level in the red can? the white can?

2. What do you think was the cause of the change?

3. What are some things that could be done to prevent this change?

4. From your observations, what can you conclude would happen to fuel levels in red farm barrels as compared with the fuel levels in white farm barrels?

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Gasoline losses for a variety of tank situations.

Tank configuration	Representative gasoline losses gallons/month
Red tank in sun	9 to 10
White tank in sun	6
Red tank in sun with pressure-vacuum relief valve	5.5
White tank in sun with pressure-vacuum relief valve	3.2
Tank in shade	2.4
Tank in shade with pressure-vacuum relief valve	1.3
Underground tank	Less than 1

Questions:

1. Why should you not fill a fuel barrel completely to the top?
2. What are some possible methods that can be used to reduce fuel losses from farm storage tanks?
3. What is the effect of a pressure-vaccum relief valve on fuel loss?
4. What might be the effect of evaporation on the quality of a fuel such as gasoline?

Conservation tip's - fuel storage

1. Fuel leaks - Examine all connections between the tank outlet and the hose nozzle as well as the hose itself. Look at the ground under the base and tank. Fuel leakage can often be corrected by simply tightening the connections.

2. Filler Caps- You should take a critical look at the filler caps on your fuel tanks. This small item may cause a loss of 40 to 50 gallons of gasoline per year if it is a conventional filler cap. A pressure - vacuum relief filler cap will cut evaporation losses in half.

3. Tank color - The dull red or old rusty fuel tanks visible on many farms waste fuel. You can cut evaporation losses by one-third by painting a dark tank white or aluminium. NOTE: (Gasoline containers which hold less than 60 gallons must be painted vermillion red. However, tanks which hold more than 60 gallons may be painted any color. White is best.)

4. Tank location- Shade makes a substantial difference in the amount of evaporation loss. When a fuel tank is completely shaded, color has little effect on fuel losses. A tank located directly in the sun will lose about four times as much gasoline as a similar tank totally shaded.

   Tank shading can be provided by a large tree, but in most instances, this tree will not provide much shade during the winter. Constructing an open-front shed over the tanks is the most effective means of shading them.

1977 Irrigation Statistics for Nebraska, P.E. Fischbach, Institute of Agricuture and Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska, 1977. (Available through local County Extension Agent.)

"Energy Uses in Machine Operations," D.E. Lane, Energy Uses in Nebraska Agriculture, Institute of Agriculture and Natural Resources in cooperation with counties and the U. S. Department of Agriculture, University of Nebraska-Lincoln, Lincoln, Nebraska, 1973, pp. 2-13. (Available through local County Extension Agent.)

"Fuel Storage", David P. Shelton and Leonard L. Bashford, Farm Energy Tips, Institute of Agriculture and Natural Resources in cooperation with counties and the U.S. Department of Agriculture, University of Nebraska-Lincoln, Lincoln, Nebraska, 1973, pp. 2-13. (Available through local County Extension Agent.)

"How Nebraska's Land is Used", Duane A. Olsen, Neb Guide, Cooperative Extension Service, University of Nebraska-Lincoln, Lincoln, Nebraska, 1978. (Available through local County Extension Agent.)

Other Readings:

"Fuel Uses," David P. Shelton and Leonard L. Bashford, Farm Energy Tips Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, 1977.

"Gear Up-Throttle Down," David P. Shelton and Kenneth Von Bargen, Farm Energy Tips, Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, 1977.

"Tractor Ballasting," Leonard L. Bashford and David P. Shelton, Farm Energy Tips, Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, 1977.

SECTION II

Title: Irrigation

Introduction:

In Nebraska, irrigation has become one of the largest areas of consumption of farm energy. Of the 23.6 million acres of cropland in the state, 7.1 million acres are under irrigation. The kinds of fuels these systems use are varied. Diesel fuel, electricity, natural gas, and L.P. gas are the four most common sources of energy used in irrigation. With the increased cost of these energy sources and the predicted depletion of some, it is evident that conservation techniques and alternatives need to be found.

When working with irrigation systems, one must realize that different areas have different needs. In western Nebraska, the water should be distributed at 17 inches/acre/year. Central Nebraska irrigators should plan on putting about 15 inches /acre/year covering of water. The eastern section of Nebraska needs approximately a 12 inch acre/year cover of water. These are all variable dependent upon soil and weather conditions in each area.

The type of irrigation system used is important when talking about energy use. Efficiency of operation is also vital. For example, the center-pivot irrigation system needs 15 times more energy to distribute water once it is above ground than any other system, yet the center-pivot is 90% efficient. In comparison, the gated pipe system is 60% efficient and the ditch and siphon systems are 30% efficient. With the implementation of reuse systems, the gated pipe and ditch methods of irrigation can be brought up to the efficiency level of the centerpivot.

Behavioral Objectives - Irrigation

The student will be able to:

(a) differentiate between surface and sprinkler irrigation systems

(b) list types of sprinkler irrigation systems

(c) list types of surface irrigation systems.

(d) list the fuel sources used by irrigation systems.

(e) identify conservation techniques in irrigation.

For latest data contact:

Source: P. E. Fischbach
Professor, Agricultural Engineering
Institute of Agriculture and Natural Resources
University of Nebraska
Lincoln, Nebraska 68583

1977 Irrigation Statistics
NEBRASKA

Year	Sprinkler Irrigated	Surface Irrigated	Total Acreage Irrigated
1929	-----	531,617	531,617
1939	-----	610,379	610,379
1949	8,295	867,964	876,259
1956	201,230	1,811,090	2,012,320
1960	250,000	2,415,000	2,665,000
1962	250,000	2,908,000	3,158,000
1964	280,000	3,091,100	3,371,100
1966	395,000	3,246,000	3,641,000
1970	865,800	3,563,320	4,429,200
1972	1,086,048	3,657,362	4,743,410
1974	1,497,956	3,840,014	5,337,970
1975	1,691,856	3,923,114	5,614,940
1976	2,322,986	3,978,414	6,301,400
1977	2,841,206	4,323,894	7,165,100

Irrigation Well Statistics	
1948	6,524
1952	8,606
1956	19,130
1963	24,372
1966	27,086
1970	35,685
7/1/72	38,461
7/1/74	43,713
7/1/75	46,483
9/21/76	52,014
1/1/77	56,163
10/1/77	60,651

Type of Irrigation Power Units	
Natural Gas	21%
L. P. Gas	12%
Electric	30%
Diesel	36%
Gasoline	1%

85% of Irrigation from Wells (Ground Water)

15% of Irrigation from streams & reserviors (Surface Water)

Range of Engine Size/Pump Capacity	
Natural Gas Engine	5 to 200 hp.
Electric	5 to 200bhp.
Diesel	15 to 200bhp.
Pumps	20 to 3,000 gpm.

Sprinkler Irrigated	
Side Roll and Tow-Line	525,000 ac.
Center-Pivot	2,219,076 ac.
Hand Move	26,830 ac.
Solid Set	5,300 ac.
Big Gun & Traveler	65,000 ac.
Total Sprinkler Irrigated	2,841,206 ac.

Surface Irrigated	
Open Ditch, Siphon Tube	780,000 ac.
Buried Pipe Lines with Valves	1,182,394 ac.
Gated Pipe Direct From Well or Canal	2,361,500 ac.
Total Surface Irrigated	4,323,894 ac.

Nebraska	
Total Land Area	49,032,000 ac.
Cropland	23,637,000 ac.
Grassland & Range	22,266,000 ac.
Sandhills	16,000,000 ac.
Other Range	6,266,000 ac.
Forest & Woodland	1,073,000 ac.
Other	2,056,000 ac.

Activity I: Energy Required

ENERGY REQUIRED FOR SPRINKLER AND SURFACE IRRIGATION SYSTEMS FROM VARIOUS FUEL SOURCES

Energy	Units %	Surface irrigation 1/ Energy required		Sprinkler irrigation 2/ Energy required		TOTAL Energy
		per acre	total	per acre	total	
Electric	30	286 kw.	368.9 mkw.	656 kw.	551 mkw.	919.9 mkw.
Diesel	36	23 gal.	35.6 m.gal.	54 gal.	54.4 m.gal.	90.0 m.gal.
L. P. Gas	12	37 gal.	19.1 m.gal.	84.3 gal.	28.3 m.gal.	47.4 m.gal.
Natural Gas	21	3796 ft^3.	3427.8 m.ft^3.	8709 ft^3.	5121 m.ft^3.	8548.8 m.ft^3.

This chart is a revised edition.

Table source: P. E. Fischbach

kw - kilowatts	mkw - million kilowatts
gal- gallons	m.gal. - million gallons
ft^3- cubic feet	m. ft^3 - million cubic feet

1. Based on 4.3 million acres irrigated by gated pipe or siphon tubes from wells total lift 120 feet - 900 g.p.m. applying 15 acres inches at 75 percent of Nebraska Performance Standards for pumping plants.

2. Based on 2.8 million acres irrigated by sprinklers from wells - total lift of 273 feet, 900 g.p.m. applying 15 acre inches at 80 percn-t of Nebraska Performance standards for Pumping plants.

Questions:

1. Which of the 2 types of irrigation requires the lesser input of energy?
2. Why do we see such an increase in sprinkler irrigation systems?
3. Will we see a change in the types or percentages of use of the various power units in the future?

Irrigation conservation techniques.

There are many possible techniques that can be used to conserve energy in irrigation, the following is a listing of some of the alternatives.

(A) Off Daily Peak Use of Electricity

In the case of electric motor driven irrigation wells, these could be programmed by the electric power district to operate off the daily peak use rate of electricity. This could mean a great savings to some rural electric districts who pay for electricity on the basis of their peak electrical loads.

(B) Installation of Reuse Systems

Another possible way to partially reduce the energy requirements for irrigation would be to install reuse (tailwater) systems on all surface irrigation systems. Twenty-five to forty percent of the water could be saved.

(C) Installation of Automated Surface Irrigated Systems

A third possible way to reduce energy requirements for irrigation would be to install automated gated pipe systems with a reuse system on the land irrigated by wells which now use gated pipe and siphon tubes. The installation of the auto-surface with a reuse system would provide the irrigator with a system with which he could use the revised irrigation management procedure, Programmed Soil Moisture Depletion with less labor than gated pipe and/or siphon tubes. The present problem with gated pipe or siphon tubes is the labor required to change irrigation sets. The irrigator usually changes irrigation sets twice a day but this practice often applies more than twice the needed water. However, with the auto-surface irrigation system irrigation sets can be changed every two or three hours automatically. The result is water applications of only 1 or 2 inches each irrigation. The autosurface system with reuse has an irrigation efficiency of 92 percent.

(D) Increasing the Pumping Plant Efficiencies

The fourth possible way to reduce the energy requirements for irrigation would be to adjust or re-engineer the irrigation pumping plants to meet the Nebraska Performance Standards as provided by the Agricultural Engineering Department, UNL. Performance Standard tests show that the average pumping plant is operating at about 80 percent efficiency of the Nebraska Performance Standard.

(E) Irrigation scheduling is another method at conservation available to the farmer. With manually operated surface systems, a big problem is applying the right amount of water and no more. The use of a water meter or some other method of measuring water would be of assistance in applying the right amount of water. Sprinkler systems do not have the problem of excess water as they are regulated by water pressure, nozzle size and time. Energy and water use could be cut down by using methods of adjustment according to soil moisture content, rainfall, and other weather data. Some irrigators are using electrical resistence blocks to determine when to start irrigating. Soil tube and sugar samples are also used to test moisture content to determine when to irrigate.

(F) An alternative source of energy for irrigation is being tested at the University of Nebraska field station in Mead, Nebraska. Experements are continuously being conducted using solar panels as collectors of the sun's radiant energy. The energy obtained is used directly in the irrigation system and is also stored in batteries for use on days when there is little or no sunshine available. This system is monitered by computer at the field site. The irrigation system being used is a surface system using gated pipe with a reuse pit and underground pipe for the reuse.

Suggested supplemental activities on irrigation.

1. Contact your local county extension agent and have him come to your school to tell about the Nebraska Irrigation Scheduling program.
2. If available, get a local irrigation equipment dealer to speak to your group about the costs of some various irrigation systems.
3. Take your group out to see different irrigation systems in action. If possible get some information about fuel consumption, amount of water pumped and any other information about the system from the farmer.
4. A field trip to Mead, Nebraska and the solar irrigation unit at the University of Nebraska Field Lab could be taken.

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SECTION III

Title: Chemicals

Introduction:

The use of chemicals to increase grain yield has become common-place in today's farming. This drive for higher yeilds includes the application of herbicides for weeds, pesticides for insects and fertilizer to promote growth. Most of the chemicals used on the farm today have been developed since 1940. The production and application of these chemicals requires a great deal of energy.

Behavioral Objectives - Chemicals

The student will be able to:

(a) determine the effects of chemicals upon our ecosystem.

(b) list alternatives to the use of herbicides and pesticides.

(c) determine the effects of composting

(d) list several advantages of composting

(e) list several disadvantages of composting

(f) determine the effects of nitrogen fertilizer overuse, both monetary and ecologically

Activity I - Fertilizers

Fertilizers have helped the United States to produce about 17 percent of the world's food with less than one percent of the world's energy. United States agricultural producers in 1976, used nearly 50 million tons of fertilizer material, about half of which was nitrogen fertilizer. Nebraska farmers used nearly 1.5 million tons of nitrogen fertilizer, applied at an average of 22 tons of material per farm.

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The sources used to produce fertilizer are listed in the following chart.

Equivalent amounts of energy required to produce 200 lbs. of nitrogen.

Energy Source	Unit energy	Total amount
Natural gas	1,050 BTU/ft^3	5360 ft^3
Diesel fuel	140,000 BTU/gal	40.2 gal
Gasoline	125,000 BTU/gal	45 gal
LP gas	95,000 BTU/gal	59.2 gal
Coal	13,000 BTU/lb	433 lb
Electricity	3,413 BTU/kwh	1650 kwh

Source: Rolofsen and Wiese, Fertilizer Management

Questions:

1. Which of the liquid fuels (diesel, gasoline, LP) produces the most nitrogen per gallon?
2. Which of the liquid fuels is presently the least expensive?
3. Using questions 1 and 2, which liquid fuel would produce the most nitrogen per dollar invested?
4. If the price of natural gas is approximately $1,50 per thousand cubic feet, how much would it cost in fuel to make 200 pounds of nitrogen by using natural gas?
5. If electricity cost approximately 2¢ per kwh (kilowatt-hour) and coal $50 per ton are these competitive with natural gas in fertilzer manufacture?
6. Natural gas is the primary energy source used to produce nitrogen fertilizer. What effects would a shortage of natural gas have on nitrogen fertilizer production?

Cost and Returns for Various Nitrogen Fertilizer Application Rates

Nitrogen applied lbs/acre	Yield increase bu/acres	Crop price $2.00/bu	Crop price $2.50/bu	Nitrogen costs $0.15/lb	Nitrogen costs $0.30/lb
		Economic returns/acre		$/acre	$/acre
40	23	$46.00	$57.50	$ 6.00	$12.00
80	11	22.00	27.50	12.00	24.00
120	9	18.00	22.50	18.00	36.00
160	6	12.00	15.00	24.00	48.00
200	3	6.00	7.50	30.00	60.00

Source: Rolofson and Wiese, Stretching Fertilizers

Questions:

7. According to the chart what rate of nitrogen application will give the farmer the greatest economic benefit?

8. At what point does the price of the fertilizer no longer remain less than the profit dervied from it?

9. Are there other reasons, rather than price vs profit, you would not want to put large amounts of nitrogen fertilizer on your corn crop?

Alternatives to Fertilizers

A. Composting: Fresh beef cattle manure contains about 85% moisture. The moisture content of feedlot manure depends on climate and length of exposure. In Nebraska's climate feedlot manure averages about 50% moisture. When composted, beef cattle manure changes from large sized masses which are difficult to spread uniformly, to small particles which can be applied as easily as commerical fertilizer.

Marked changes also occur in the chemical composition of composted beef cattle manure obtained at the Mead Field Laboratory and from Mid American Compost. During composting, manure, cellulose and fiber decompose and water is lost. The total mass or volume of the waste is reduced. On the average, 4 to 6 tons of beef cattle manure will be converted to one ton of finished compost.

Composting is the process of biological decomposition of organic wastes or mixtures of organic wastes that have been piled together. The resulting products are similar to soil organic matter in that a great deal of the cellulose and fiber in the wate have been consumed by microorganisms.

A compost pile requires lots of air for the microorganisms to break down waste. The heat generated by composting pasteurizes or kills disease organisms in the wastes. The compost is generally aerated by mixing when the temperature is around 140 to 150 degrees F. Composting under controlled conditions will conserve and concentrate the nitrogen in the manure. If the compost pile is allowed to overheat, nitrogen can be lost as ammonia. Under these conditions, a strong ammonia odor can be smelled when the waste is turned.

Applying organic wastes to soils markedly improves soil structure, increases its water intake rate and soil aeration. With moderate continued application of organic wastes, there is a bonus of greatly reduced runoff of rainwater.

Composting is an ancient art. It is practiced on a small scale by many organic and backyard farmers, but specialized equipment has or has not been developed to handle large volumes of wastes.

Composition range of beef cattle feedlot manure and composted feedlot manure.

	Feedlot manure	Composted manure
Moisture %	50-80	19-25
Nitrogen %	0.9-1.5	2.0-3.0
Phosphorus %	0.3-0.5	0.9-1.2
Potassium %	0.6-1.8	2.8-3.5
Sulfur %	0.2-0.3	0.4-0.6
Zinc Parts/million	82-125	156-226

Source: Leon Chesnin, Farm, Ranch, and Home Quarterly, Fall, 1977.

Animal and human manure production in Nebraska.

Source	Tons/year, wet
Cattle	61,251,380
Swine	2,184,290
Poultry	603,861
Sheep	27,010
Total animal waste	64,071,541
Human	90,800
Paunch manure (stomach contents of slaughtered cattle)	94,000
	64,256,341

Source: Leon Chesnin, Farm, Ranch, and Home Quarterly, Fall, 1977.

Questions:

1. What are some drawbacks or problems associated with composting?
2. If all the waste products in Nebraska were composted it could provide 1000 lbs. of nitrogen for every acre of farm ground in the state. Why isn't this practice more widespread than it is?

Alternative nitrogen sources and conservation practices.

1. A crop rotation program with a legume, a plant that fixates nitgrogen in the soil, can be used to reduce nitrogen fertilizer consumption. Such crop rotation is recommended wherever economically and environmentally feasible.
2. Nitrification inhibitors help to prevent leaching, washing of fertilizer into lakes, streams, and ponds, of many nitrogen fertilizers. This will result in having to use less fertilizer and thus save energy and money.
3. Testing irrigation water for nutrient content will help you plan good fertilizer management. Plant nutrients such as potassium, boron, magnesium, and sulfar are present in irrigation water. If these elements are present in amounts adequate to meet crop needs, then purchases and application of these minerals as fertilizer is unnecessary. In some parts of the state, there may be enough soluble nitrate nitrogen in irrigation water to be of fertilizer value. A chemical analysis is necessary to determine what minerals are available.
4. Soil testing by farmers make it possible to predict the amount of fertilizer needed to produce the best yield for a particular crop. Testing checks for nutrients availability and carryover, and provides a base from which to recommend fertilizer application rates.

Activity II: Comparing Composting to Dry Nitrogen Fertilizer

Purpose: To demonstrate the feasibility of using composting as an alternative to the use of commercial fertilizers.

Procedure:

Part 1 - Take 2 pounds (approximately) of fresh manure and add some straw. Leave this set on the ground in an area designed by the instructor. Check the temperature of the inside of the pile twice daily. If the temperature reaches 68 degrees C or above, mix the pile thoroughly so that the manure on the inside is exposed to the air. When the temperature of the inside of the pile stays around 15 degrees the composting is complete. (Start part one at beginning of semester)

Part 2 - Use a mixture of 1/3 soil, 1/3 sand, and 1/3 compost. Place in a styrofoam cup. Plant several beet or radish seeds in the mixture. In another cup put a mixture of 1/2 soil and 1/2 sand. To this mixture add about a tablespoon of a dry commercial fertilizer. Plant several beet or radish seeds in the mixture.

In a third cup put a mixture of 1/2 soil and 1/2 sand, but do not put any compost or fertilizer in with the mixture.

Be sure to add two teaspoons of water to each cup daily.

From your observations answer the following.

1. Which seeds sprouted the fastest?

2. Which cup seemed to produce the best growth of seeds?

3. What, if any, conclusions can you make from your results?

Activity III: Insecticides

Probably the best known of the insecticides is DDT. In its 25-30 year span of use it has helped prevent diseases, make many uninhabitable places liveable and generally control farm insect pests. But like many chemical insecticides its use has been questioned because of the damage to other parts of the ecosystem. It has been attributed to causing deaths in birds and reduction of certain species by causing the eggs to have weak shells.

The ability of insects to compete with men for food and fiber is well documented. The U.S.D.A. reports annual losses from insect damage to crops in the United States at an estimated $4.0 billion. The need for insecticides was clearly evident in Nebraska in 1977 and 1978 with the increase in the grasshopper population.

Several practices should always be followed in using any chemical or application equipment (U.S.D.A.).

1. Know how to use the chemicals and application equipment, including their limitations. Read all the literature on their use carefully.
2. Read pesticide labels carefully before using any chemical in any equipment.
3. Wear proper protective clothing when filling or emptying equipment and during application.
4. Do not make chemical application during unfavorable weather; I.E. strong winds, hot periods, cold periods, etc.
5. Check all equipment constantly for malfunctions, and use a strong preventive maintenance program.

Chart of Insecticides.

Type	Chemical name	How they control	Environmental effect
Chlorinated hydrocarbons	DDT, Chlorodone, aldrin, endrin, dieldrin, BHC, DDD, lindane, Heptachlor, toxaphene	contact poison, usually attack nervous system	Bad, ususally have long residual effect, can build up in food chain
Organic phosphate	parathion, phosdrin, systox	are systemics, taken in as part of plant, stomach poison, good for sucking insects	very little effect, no residual effect, won't be carried out of target area, but are extremely toxic to man
Carbonates	furidan, termik sevin	contact poison	moderate, short residual effect, generally highly toxic, are very destructive to some beneficial insects (bees, wasps)
Botanical Compounds	Pyrethrins, nicotine, sabadella, ryania	contact poison	can be toxic, no residual effect
Spray oils	hydrocarbon product	coat and smother	none

Alternatives to Insecticides.

A large number of insect control strategies are available to man. Some of these are:

1. Parasite and predator control - use of beneficial insects and other animals to destory injurious pest species.
2. Cultural control- use of sanitation, tillage, crop rotation, land management, plantings timings, and other cultural methods of insect control.
3. Physical and mechanical control - use of barriers, light trays and sound as part of past control approaches.
4. Hormones and feeding deterents - use of actual and synthetic sex pheromones to attract insects.
5. Microbial control - use of insect diseases such as virus, fungus and bacterial disease that attach insects.
6. Plant resistance - development of plant species that are not attacked or resist attack of destructive insect pests.
7. Sterilization - the use of chemicals, radiation, etc., to sterilize pest species thus reducing chances of development of additional off-spring.
8. Regulatory control - the use of laws and regulations to reduce the movement of pest species.

Source: Washington State University and U.S.D.A.

Questions:

1. Which of the alternatives have you seen or heard of being used in Nebraska?
2. What things are taken into consideration when choosing an insecticide?
3. Will we ever be able to completely stop using chemical controls for pests?

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Activity IV: Insecticides (Role playing)

Divide into three groups of nearly equal size.

Group I - Investigate (use library and other resources) the benefit of the use of insecticides

Group II - Investigate the effects of insecticides on our ecosystem

Group III - Investigate the government controls and regulations placed on insecticides.

Group I will represent a group of farmers, Group II a team of environmentalist and Group III a committee of legislators.

Situation: Nebraska has been plagued by the worst grasshopper infestation of 50 years. A group of concerned farmers has petitioned for the release of banned pesticides to fight the grasshoppers. A legislative hearing has been called to present the farmers case. The environmentalists have come to argue for not releasing the chemicals.

Each side should present its views with the legislators possibly making a decision.

Herbicides -

The majority of herbicides are hydrocarbon based chemicals. Thus fossil fuels (energy) are used up in both the production and application of herbicides.

Herbicides are of two types. Preemergence herbicides are applied to kill weeds while they are germinating or shoots. Postemergence herbicides are planted a little deeper and kill older plants by absorption through the root system.

For greatest energy savings the herbicides should be applied with the fertilizer. A single application saves time as well as labor and reduces soil compaction by elminating a field operation.

Alternatives -

The best alternatives to reduced use of herbicides were the cultivation practices discussed in the farm machinery section.

Questions -

1. What are some of the precautions that must be taken when using herbicides?
2. What is meant by carryover? How does this affect the choice of herbicides?

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Other Readings:

"Soil Testing," Dale E. Rolofson and Delno Knudsen, Farm Energy Tips, Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, 1977.

"Water Testing," Dale E. Rolofson and Delno Knudsen, Farm Energy Tips. Cooperative Extension service, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, 1977.

ENERGY RELATED PUBLICATIONS

Nebraska Cooperative Extension Service

April, 1979

Single copies of most of the publications listed below may be obtained from the Cooperative Extension Service Offices located in every Nebraska county. The publications are free for Nebraska residents unless a cost is listed.

Most of the publications can also be obtained from the Department of Agricultural Communication, University of Nebraska Lincoln, NE 68583, unless another source is listed. Nebraska residents may obtain single copies of up to 10 different publications free. Information about purchasing a quantity of any of the publications can be obtained from the department (472-3020).

I. Agriculture and Natural Resources:

A. Farm Energy Tips -

CC	270	Fuel Storage
CC	271	Fuel Use
CC	272	Fertilizer Management
CC	273	Stretching Fertilizers
CC	274	Soil Testing
CC	275	Water Testing
CC	276	Alternative "N" Sources
CC	278	Tractor Ballasting
CC	279	Gear Up - Throttle Down

B. NebGuides -

G	73-51	Grain Drying with Less Energy
G	73-52	Acid Preservatives for Grain
G	73-58	Top Yields With Least Water
G	74-76	Wet Grain Storage
G	74-95	Natural Air Drying of Grain
G	74-103	Heating With Wood
G	74-123	Weed Control in Minumum Tillage Corn
G	74-131	No-Till Corn in Alfalfa Sod
G	78-413	Nitrogen Management on Soil Irrigated With Groundwater Containing Nitrate

C. Others -

CC	257	Energy Conservation in Agriculture
EC	70-791	Insulation and Heat Loss - Keeping Livestock Buildings Warm

The following publications are available from 101 Agricultural Engineering, University of Nebraska, Lincoln 68583 (472-3948):

AE - 88	Solar Heating for Home, Farm and Small Business. 25¢ ea.
RCD - 10	How to Set Up a Coal or Wood Stove. (Free from Rollin Schnieder, Extension Safety Specialist)
NE - 191	Burning Wood. $1.00 ea.
NRAES - 3	Energy Conservation and Solar Heating For Greenhouses. $1.50 ea.

Energy Publications (cont.)

II. Home Economics:

A. NebGuides -

HEG 77-85	Energy Choices in the Kitchen
HEG 77-86	Winning Ways With Water
HEG 77-87	Be Aware of What You Wear
HEG 78-90	Your Electric Blanket
HEG 78-94	Electrical Appliances and the Energy $
HEG 79-95	Easy on Energy - With Appliances
HEG 78-96	Easy on Energy - At Home

B. Energy Conservation in the Home-

EC 73-2025	There is an Energy Crisis
EC 73-2026	Kitchen
EC 73-2028	Building and Remodeling
EC 73-2029	Cooling
EC 73-2030	Heating
EC 73-2031	Outside the House

C. Others -

EC 74-2033	Structural Lighting in the Home
EC 78-2051	The Effective Detective - Finding Energy Savings at Home

NCR Extension Publication 73 - Saving Energy With What You Wear

Teacher Key to Questions:

I. Machine Operation

A. Tractor efficiency

1. Around 60%
2. Abnormal engine wear may occur, may cause engine to blow up, (may be other answers)
3. Answers should be to the effect that poor maintenance will yield poor tractor efficiency.

B. Cropping methods

1. 8.55 gallons of gas, 5.95 gallons of diesel
2. $5.17 gas/acre $2.68 diesel/acre
3. Minimum tillage is a farming method where machine operations are held to a minimum. The natural mulch in a field (i.e. stalks, straw) are mixed with the soil in the least steps possible.

   Minimum tillage is far less energy consuming than conventional methods of farming.

C. Fuel Storage

Laboratory Exercise

1. Water level has risen in the red can. Water level about the same in the white can.
2. Change caused by the expansion of the liquid as it was heated by the sun.
3. Main thing is to keep the fuel containers in the shade.
4. The fuel in the red barrel will expand more than the fuel in a white barrel.

Fuel Storage Questions:

1. The fuel will expand and run out the top.
2. (A) Check for leaks
   (B) Place in shade
   (C) Paint tank white when possible.
   (D) Put on pressure-vacuum relief filler caps.
3. Reduces fuel losses to about half.
4. Lowers the quality of fuel because the lighter fractions of the fuel will evaporate off. Makes cars and tractors harder to start in cold weather. May cause gumming up of the engine.

II. Irrigation

1. Surface irrigation systems require less energy.
2. Saves many man hours of work, have higher efficiency in getting water onto crops.
3. Will probably see a shift to largely electric, may perhaps see some solar equipment.

III. Chemicals

A. Fertilizer

1. Diesel fuel
2. LP gas
3. Approximate costs - LP - \$.35/gal
   diesel- \$.45/gal
   gasoline - \$.65/gal

   calculations- LP - 200 ÷ (59.2 X .35) = 9.65 pounds/\$invested
   diesel-200 ÷ (40.2 X .45) = 11.06 pounds/\$invested
   gasoline -200 ÷ (45 X .65) = 6.84 pounds/\$invested

   Therefore, diesel would produce the most nitrogen/dollar invested.

4. 5360 ft^3 to make 200 lb. of nitrogen 1000 ft^3 cost \$1.50

   5.36 X 1.50 = \$8.04 to make 200 lbs. of nitrogen

5. Electricity

   1650 Kwh X .02/Kwh = \$33.00 to make 200 lbs of nitrogen

   Coal

   $\frac{433}{2000}$ X \$50/ton = \$10.83 to make 200 lbs of nitrogen

   These are both more expensive than natural gas.

6. Cause higher prices, create shortage.
7. The first 40 lbs. of application.
8. Anything above 160 lbs/acre
9. Can burn up crop, can leach out into environment (water supplies)

Alternatives to Fertilizer

1. Odor, attract insects and disease, volume of waste material, calculation of application rates.

2. Accessability of reasonably priced commercial fertilizer, time needed for composting, machinery needed for application.

Alternatives to Insecticides

1. Answers will vary

   Possible answers-parasite and predator control (lady bugs), physical and mechanical (used around eating establishments) plant resistance (greenbug resistant milo).

2. Availability of insecticide, the pest involved, price, type of application, toxic quality of the insecticide.

3. No, there will always be insect pests to be controlled (good area for discussion).

Herbicide Alternatives

1. Weather conditions, proximity to orchards and gardens, carryover.

2. The effect of the herbicide onthe next crop to be planted in that field. You must choose a herbicide that will not kill or retard the growth of future crops on the land.

NO ENERGY

Recommended Level: Grades 8 and 9
Time Required: Ten Days

by
Gaylord Peterson

Prepared for
The Nebraska Energy Office

NO ENERGY?

Abstract

In your generation the needs for gas and oil will outstrip the world's supply creating a visable crisis of monumental proportion. Within your lifetime the world must search out and develop new and alternative sources of energy and that will require cooperative efforts of governments, businesses, industries, and the general population of the world. Efforts must begin with conservation as available oil and gas reserves become increasingly precious. Surviving the energy crisis will make energy conservation and development of energy sources a matter of everyone's business. The problems of energy are your business.

Recommended level - Materials prepared here are intended for use with grades eight and nine but can be used without change in grades six through ten.

Time required - The time span intended for this unit is ten days. Lesson guides are included for all but the first and last days. The first day should be used to set a tone of inquiry and interest as students are asked to read any of the bulk of materials which are readily available on the subject, use films or filmstrips made for this use, or discuss with the teachers guidance the problems of world energy supplies. A small amount of preparation by the teacher may be needed for a good introduction. An activity (#3 of Lesson Two) must also be started the first day. The last day should be used for evaluation of information gained and activities used.

Major teaching strategies - It is planned that each days activities may be preceded by a short lecture or discussion of the days efforts led by the teacher, but this may not be needed depending on the class. There is a list of complimentary activities at the end of the lessons for the "eager beavers" who finished assigned activities. If daily evaluation is desired, the teacher will have to make time in the lesson. These materials are not intended to be limiting and the teacher may wish to include other things, or delete some portions. A list of selected sources are included at the end of the lessons but most daily directions are self-contained and only a moderate library of texts and reference materials is needed. The teacher can acquire a variety of printed matter from many sources which are easy to contact.

Essential advanced preparation - For each days activities a small amount of preparation may be necessary for gathering equipment or gaining background to effect efficient utilization. It is obvious that the teacher should gain a personal background in the subject, but it is more important that teachers know where information can be found.

Goals - As expressed are some generalizations that students should be able to make upon completion of the unit. Each days lessons include behavioral objectives.

1. The worlds energy use increases with the increasing population, the improving standard of living, and the increase in the number of demands on energy to ease human effort.

Goals (cont).

2. The principle source of energy in the world is fossil fuels (petroleum, natural gas, coal) but the sun, wind, tides, heat from the interior of the earth, nuclear energy, and chemical uses are increasing.
3. While fossil fuels seem to be abundant in the earth today, and the discovery and development technology continues to improve, the quantity is not infinite and reserves will become depleted.
4. Nuclear fission and fusion may be the most promising relief to problems of energy supply for the earth.
5. Much is being done to find alternative energy sources but they are expensive to develop, and will take a long time to implement in replacing depleted fossil fuels.
6. To delay the shortage of fossil fuels, conservation measures must be taken to reduce consumption, make fuel use more efficient, and keep the cost of energy use within the economic range of the population.
7. Increasing world populations exert greater demands upon the enviornment and its energy resources, so the regulation of population growth may help to ease the problems of energy.

Lesson One - The Worlds Use of Energy 1 day

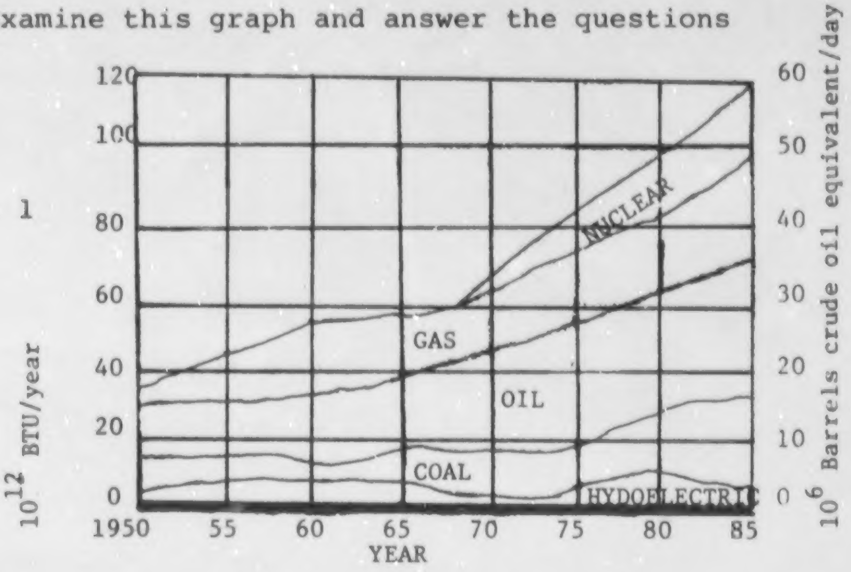
Behavioral Objectives - After completing this lesson the student should be able to:

1. Explain past, present, and future energy uses in the United States by using a graph.
2. Compare the relative quantities of energy used in each sector of life and be able to match the percent of use with the proper life sector: domestic, commercial, industrial, transportation.
3. List in decreasing order of BTU's the use of energy in his home by heating and other appliances.

Vocabulary: Consumption, BTU, efficiency, oil equivalent, industrial revolution.

ACTIVITY ONE: Examine this graph and answer the questions that follow:

Figure 1



1. What does 10^6 mean? 10^{12}?
2. How much energy was used in the United States in 1960?
3. How many barrels of oil is equal to your answer?
4. What fossil fuel is in greatest use today?
5. Which energy source seems likely to grow most in importance in the near future?
6. How much energy will be needed per year in the U.S. by 1985?

Activity One (cont).

7. Beyond 1985, which sources will be used more, and which less?

ACTIVITY TWO: Examine Figure 2. In 1976, the sectors of life used the indicated percentage of the total energy package and the fuels were used with the listed percent of efficiency. On the basis of this data, where should we concentrate our efforts to conserve energy? Why?

Figure 2

Sector	% of energy use	% of efficiency
Residential	25.2%	65%
Agricultural	9.3%	75%
Commercial	17.2%	65%
Industrial	19.3%	70%
Transportation	27.2%	25%
Government	1.8%	55%

ACTIVITY THREE: Discuss the changes in energy use through the history of man.

ACTIVITY FOUR: Examine Figure 3 on residential energy usage:

Figure 3

Space heating	47.2%	Water heating	13.2%
Space cooling	10.7%	Refrigerator	6.3%
Freezer	5.4%	Lighting	4.8%
Range	3.7%	All other uses	5.5%
Dryer	3.2%		

1. What is the total percent of energy used by the top three users?
2. What is the total percent of energy used for heating and cooling?

Activity Four (cont).

3. What does the answer to #2 tell you about making the best use of home energy?
4. Based on this data, is it really important to concentrate on shutting off room lights when they are not in use?
5. What kinds of practices would be of greater benefit? Discuss this in class.

****

In Lesson One, students are asked to develop skills in reading charts and graphs and will need to draw some conclusions. In Activity 3, don't let students forget to include human power, animal power, and introduce the Industrial Revolution in its proper order. You may want students to know dates or relative chronological order for uses of different fuels. In Activity 4, students could list appliances included in the 5.5% group to see the large number of demands we place on electricity.

Lesson Two - Sources of Energy - Fossil Fuels 2 days

Behavioral Objectives - At the end of this lesson, students will be able to:

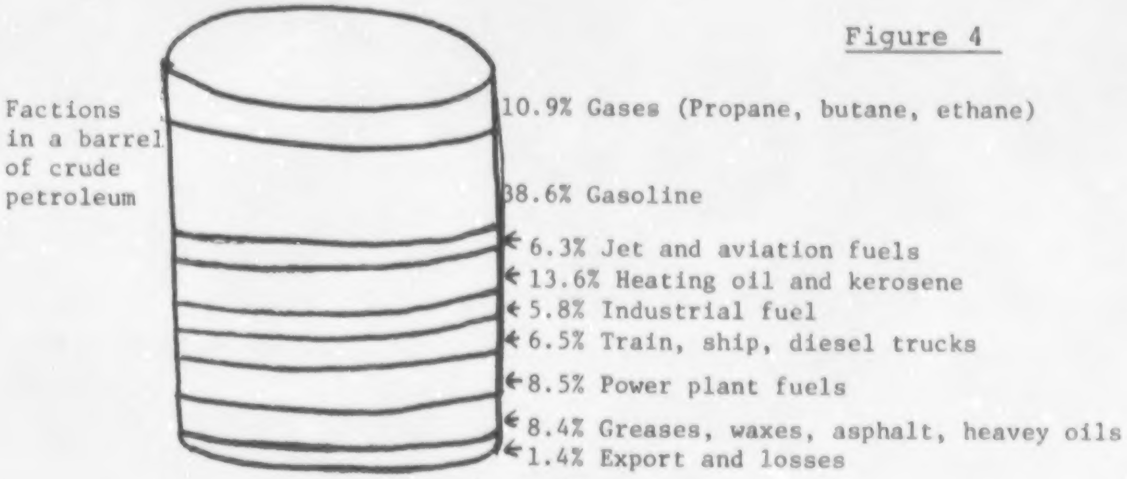
1. Describe the formation of fossil fuels with respect to time, place, and formative materials.
2. Compare the relative quantities of the main factions in crude petroleum, and their relative densities.
3. Describe the conditions which give rise to the formation of natural gas and other fuel gases.
4. Describe the process by which coke is made.

Vocabulary: density, crude petroleum, coke, charcoal, coal tar, coal gas, factions

ACTIVITY ONE: In an Earth Science, Biology text or encyclopedia, read the description of how coal, petroleum, and natural gas were formed. When you have the main ideas in mind, write in your own words how each is formed including the time span involved, the location of formation, and the things from which each is formed.

ACTIVITY TWO: Examine this picture graph and answer the questions which follow.

Figure 4



Activity Two (cont)

1. Does the location of each faction on the graph tell anything about the density of each material?
2. When crude petroleum is processed, the top half or lightest factions make up about half of the volume. What two fuels are removed from "the top"?

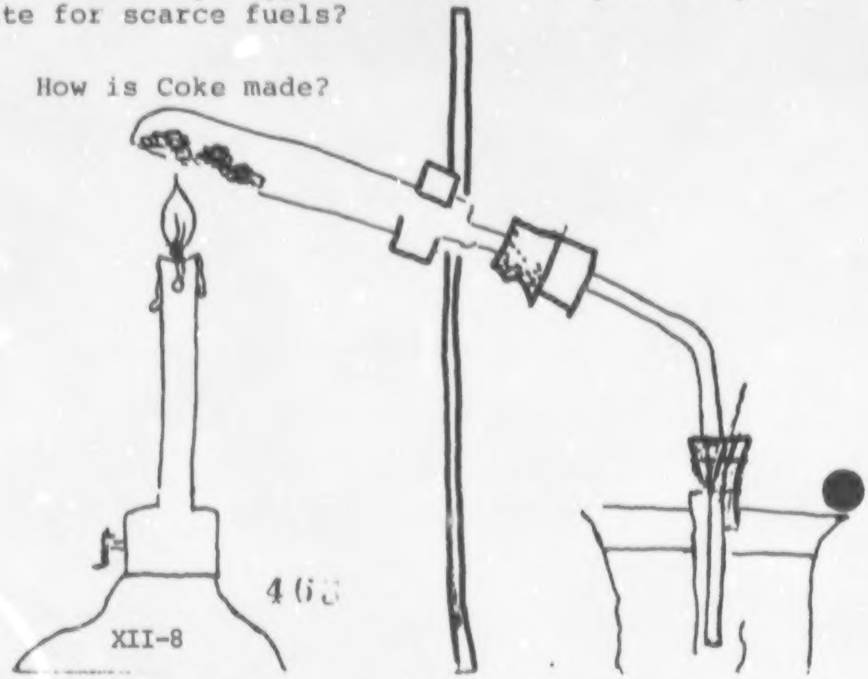
ACTIVITY THREE: Conditions that form fuel gases.

Place about 10g. of uncooked hamburger and about the same quantity of lettuce leaf in a bottle or flask. Cover its neck with a balloon and fasten it securely with a rubber band. Set the apparatus in the sun where it will be warm for several days. Stretch the rubber of the balloon and leave the arrangement until the balloon gets no larger. Answer these questions:

1. What materials is in the balloon?
2. What takes place in the bottle to cause this to happen?
3. How is this like the formation of natural gas?
4. Why does a drowned animal float to the top of the water after a period of time?
5. How could you determine if the material in the balloon is a fuel?
6. How does this activity suggest a method for producing a substitute for scarce fuels?

ACTIVITY FOUR: How is Coke made?

Figure 5



Activity Four (cont)

Set up the apparatus as shown. Place a few small pieces of coal in the test tube. The beaker should contain cold water. Draw a small nozzle from a piece of glass tubing to allow gases to leave the second tube. Coal tar should form at the bottom of the second test tube and the coal gas coming off the second tube can be burned. Coal heated with little air contact forms coke.

When the appartus is cooled, examine a piece of coke. Burn it with a piece of coal to see which burns faster. Which do you think produces the most heat? What could be done with the coal gas? Coal tar is used to make a variety of common items. Use the encyclopedia to find out what some of them are. Charcoal is made in the same manner using wood instead of coal.

****

Lesson Two examines the fossil fuels, their formation, and characteristics. Methane produced in Activity 3 can be burned if you can fasten glass tubing and a nozzle into the balloon and blow the gas over a burner flame. The nozzle here and in Activity 4 are made by heating a piece of glass tubing until soft, pulling it apart, and fire-polishing the ends. Activity 4 requires a even and moderate heat under the coal. Coal is easily found around most railroad tracks and only a small amount is needed. The coal gas may not burn well because of the uneven nature in which the gas is produced so "burning" it is best done with a candle below the nozzle outlet. Throw away the testtubes as it will be nearly impossible to clean them. Odor of sulfur in the coal tars is strong, but this provides a vehicle to bring up the inherant pollution with coal burning.

Lesson Three - Fossil Fuel Shortages 1 day

Behavioral Objectives - At the end of this lesson, the student will be able to:

1. List reasons for shortages of fossil fuels.
2. Describe the history and future of fuel production and use.
3. Compare the burning characteristics of the fossil fuels including advantages and disadvantages.

Vocabulary: See Activity One

ACTIVITY ONE - Following is a list of terms. Tell how each is related to the shortage of mineral (fossil) fuels.

a) strip mining
b) sulfur pollution
c) lines at gas stations
d) brown out
e) high electric bill
f) oil imports
g) reserves
h) oil shale
i) tar sands
j) coal gasification

You can use an Earth Science text or some other source to find the relationships.

ACTIVITY TWO - In class discussion, bring out the reasons for shortages of fossil fuels. Many of these will be related but include them separately. Listen carefully for reasons suggested by your classmates and, in very brief form, note all the reasons in a list.

ACTIVITY THREE - Using dates only, find in a reference source the important dates related to petroleum discovery, preparation, use, and future. Put these on a time line including the year and what happended. Keep this for later use.

ACTIVITY FOUR - Plan an experiment which will tell how any two of the three fossil fuels could be compared to see which produces the most energy by weight. If it is well planned, Activity Four (cont)

your teacher will suggest that you skip the next lesson and do the experiment instead.

****

In Lesson Three, a little more reference research is used but it has value. This may also be a lesson during which some complimentary activities can be done, the unfinished activity in other lessons could be completed, or the teacher may want to provide some of the facts and figures concerning the fossil fuel shortage. You may find that a day in the library will support these objectives.

Lesson Four - Nuclear Energy 1 day

Behavioral Objectives - At the end of this lesson the student should be able to:

1. State three reasons why nuclear energy should be used more in energy production,
2. Diagram and describe the workings of a nuclear power plant for the production of electric current.
3. Compare and contrast nuclear fission and fusion,
4. Propose two arguments against the use of nuclear energy.

Vocabulary: fission, fusion, uranium, synthetic, efficiency, condensor, reactor, sabatoge.

ACTIVITY I - Read the following and answer the questions below.

WHY NUCLEAR...

America is a fast-growing nation of men, machines and tools that yearly demands more than a trillion kilowatt-hours of electric power to insure its high standard of living. Around the world expanding populations and appliations of electricity have created an ever increasing hunger for power, a demand that is predicted to increase rapidly in the next ten years -- just as it has every decade since electricity first was put to work for the benefit of manking.

To satisfy this national and world-wide appetite for electricity, progressive utilities such as Nebraska Public Power are actively working to develop new sources of power to add to those that have long been used.

Nuclear energy is by far the most important of these new power sources. Power from the atom promises lower cost electricity. Uranium, from which this energy is released, supplements our reserves of conventional "fossil" fuel -- such as coal, oil and natural gas used in generating electricity. By using the abundant supply of uranium, nations can now solve the problem of inadequate fossil fuel reserves, and conserve these fuels for other uses -- from synthetics for plastics to gasoline for cars.

More than 100 electric utilities around the world are engaged in nuclear power programs. These forward-looking companies, working with the government and manufacturers, have helped improve the design and operating efficiency of nuclear power plants. Most importantly, this improved efficiency has helped lower the cost of producing electricity from the atom to a price below that possible with fossil-burning power plants in many parts of the United States and overseas.

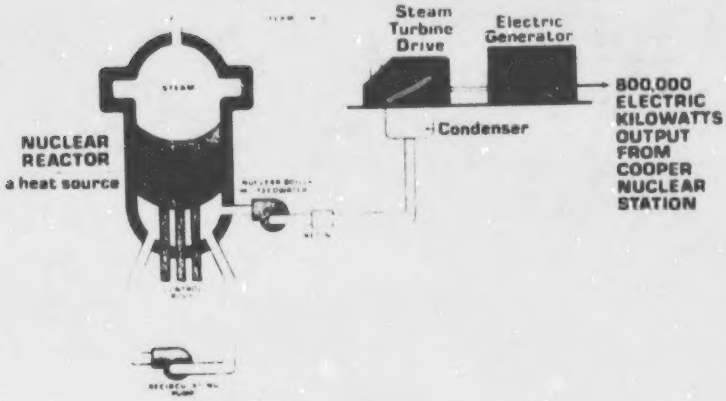
1. How much electric power does the U.S. demand each year?
2. Is this likely to increase or decrease?
3. Is electrical energy a national need only?
4. What fuel is used to power nuclear power plants?
5. What needs, beside energy, do fossil fuels meet?
6. There are 46 nuclear plants in the U.S., what percent is this of the worlds total?
7. Do you think that the U.S. could be called a leader in the use of nuclear energy use? Explain your answer

ACTIVITY TWO - Examine the chart on the next page. It shows the workings of the Cooper Nuclear Station near Brownville, Nebraska.

Activity 2 cont.

the plant...

The boiling water reactor concept


Steam
Turbine
Drive
Electric
Generator
800,000 ELECTRIC KILOWATTS OUTPUT FROM COOPER NUCLEAR STATION
Condenser
NUCLEAR REACTOR
a heat source

Facts about such a plant...

1. Steam takes up more space than water.
2. Steam moving over turning blades cause the turbine to spin.
3. The turbine is attached to the generator by a shaft which causes the generator to turn and produces the current.
4. Steam changes back into water in the condenser.
5. The nuclear reactor makes heat to produce the steam and replaces the boiler in a coal-fired power plant.

ACTIVITY THREE - In a resource of some kind, find and write the definitions for fission and fusion.

ACTIVITY FOUR - There has never been a death due to accident at a nuclear power plant. You are 2000 times more likely to be

Activity 4, cont.

killed in a car wreck than at a nuclear power plant. A nuclear power plant has never blown up. A grain elevator is 500 times more likely to blow up than a nuclear power plant. Just why do people feel that such energy makers are not safe? List all the reasons you can think of, then read these items: (The following items are from Department of Energy brochures)

SAFEGUARDING OF NUCLEAR MATERIALS

> Since the dawn of the atomic age in the early 1940's, the importance of protecting nuclear materials against theft or diversion and the necessity of protecting nuclear facilities against sabotage has been recognized and precautions have been taken. Certain nuclear materials, such as plutonium and highly enriched uranium, can be used to make nuclear weapons. And since plutonium is potentially hazardous if sufficient quantities enter the body, it is extremely important that our protective systems be highly effective and that they be continually evaluated to assure their effectiveness. Sabotaging of nuclear facilities could create a serious public safety problem and in some cases adversely affect our national security.
>
> For these reasons, there has been an intense safeguards effort under way for a number of years -- both in the U.S. and in other countries.
>
> The risks of accidents in nuclear power plants involving the release of radioactive material has become a matter of public concern. Some fear that such accidents could allow the escape of radiation in amounts that might have catastrophic effects.

Since a large portion of the new electric generating capacity being built in the United States is nuclear, the public has every right to demand assurance that its health and safety are being protected in the design, construction, operation, and regulation of nuclear plants.

Lesson Five - Alternative Energy Sources. 2 days

Behavioral Objectives - At the end of this lesson the student should be able to:

1. List five major alternative energy sources and state an advantage and disadvantage for each.
2. Describe a homemade solar heat collector.

Vocabulary: hydroelectric, geothermal, double glazed, absorber.

ACTIVITY ONE - Read about these alternative energy sources: (taken from DOE brochures)

WATER POWER

Use of a Renewable Resource

Falling water in streams and rivers has been harnessed to produce electric energy for almost one hundred years. As it falls, the water passes through turbines which turn to generate electricity.

In the mid 1930's, hydroelectric power comprised about 30 percent of the nation's total generating capacity. As fossil fuels came to be relied on more and more, however, and as many of the best sites for hydro were developed, the relative controbution of hydro to the nation's capacity decreased, to 20 percent in the early 1960's and to 15 percent in 1978.

ENERGY FROM THE WINDS

Wind power--one of the world's oldest energy systems--is now being reexamined and could begin whistling down the comeback trail in the years ahead. The total amount of wind energy theoretically available is tremendous and inexhaustible. Wind systems are one of many energy concepts now being studies by the Energy Research & Development Administration (ERDA).

Activity 1, cont.

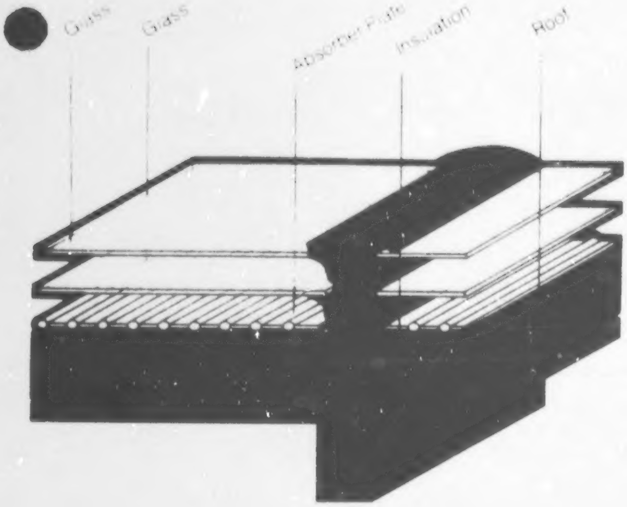
Geothermal energy, the natural heat of the Earth, promises to be an important source of supplemental power in selected areas around the world. It is estimated that the Earth's geothermal heat may represent a total energy resource equal to 21 million tons of oil per square kilometer of the Earth's surface. While most of this energy is too diffuse to be recovered, there are concentrated pockets of heat within the Earth's crust that are accessible and that could provide a significant contribution to local energy needs. Currently, two geothermal fields account for two-thirds of the world's total geothermal generating capcity: the 500 Mw* capacity field in California, The Geysers, and a comparable site at Larderello, Italy. Increased exploration and new technolgoies could increase the total U.S. geothermal generating capacity as much as 20,000 Mw by 1985. This would represent about two percent of the total electrical generating capacity expected by then.

ACTIVITY TWO - Read the following on solar.

Human kind has always looked to the sun for warmth. It was our only source of heat during those hundres of thousands of years of fireless prehistory and, since fires themselves are so inefficient, was still the major source of heat until the real beginnings of the industrial age 200 to 300 years ago.

Premitive solar heating was relatively technology-free. Our ancestors took the sun's heat when and where they could get it. In the past few generations, however, our expectations of comfort have changed and we have become accustomed to a dwelling that that is warm throughout, not just around the fireplace. In the warmer, affluent countries we also expect summertime air-conditioning of our houses, offices, cars, and even apparently, our ball parks. We not only want all of the buildings heated or cooled, but also want immediate control over the temperature and now must rely on electrical or fuel burning furnaces, air conditioners, and hot water heaters.

Solar heating and cooling technology, however, has existed for some time. The MIT solar house in Boston has obtained more than half of its heat energy from the sun for 20 years. There were perhaps 50,000 solar hot water heaters in Florida in the 30's and 40's and evaporative coolers for home air-conditioning are still used in the Southwest. Although there are no published estimates for the percentage of clothes dried by solar energy, we would guess that backyard clothesline loads are still far heavier than those processed by electric and gas-heated indoor dryers.



A variety of collector designs is now available commercially at prices ranging from $7.00 to $12.00 per square foot. An average size home requires 500 to 700 square feet of collector depending on factors such as collector efficiency, location, orientation, area and layout of the house, and energy conserving features. Designing for conservation (careful siting, heavier insulation, smaller windows, well-placed shrubs and trees, etc.) can mean smaller collector and storage requirements, thus reducing some of the solar system costs while increasing operating efficiencies.

At the left is a model of a commercial solar collector. It is called a "double-glazed" collector. Can you see why? A person who makes windows is called a "glazier". You can make a collector by replacing the glass with plastic. The absorber plate can be any dark surface. Between the glass layer and the collector surface the air or tubes of circulating water are heated. In this way a solar collector can also be used to heat water for the home. To finish this activity, get together with a classmate and build a solar collector from any scraps you can find and test its heat output.

Lesson Six - Conserving Energy Resources 2 days

Behavioral Objectives - After doing this lesson, the student will be able to suggest 10 ways to conserve fossil fuels within his own environment.

Vocabulary: insulation, caulking.

ACTIVITY ONE - We have already defined some important areas where energy, and therefore, fossil fuels can be conserved. The most important of these is transportation. Secondly, the amount of energy and fuels used in space and water heating and cooling in the home. If we can reduce use in these areas we can do a lot of saving. Following are some questions for which answers can lead us to some money and energy saving ideas.

1. What are some things that your family can do to reduce the number of miles of driving it does?
2. What are some things that can be done to make automobiles and other vehicles better able to use fuels more efficiently?
3. What are some things that can be done in your home and school to cut down on fuel use and heat loss?
4. How could your family cut down on the use of hot water and loss of heat by heated water?
5. What are some things that could be done to your house that would keep an air conditioner from running so much?
6. There is an important additional benefit from these conservation measures. What is it?

ACTIVITY TWO - A home economist, gas company representative, building supplies salesman, home builder, heating/cooling expert, auto mechanic, county extension agent, or many people in many walks of life have gained much knowledge in the area of energy

Activity Two, (cont).

conservation. Suggest a person that we could invite to school to talk to us about what they have learned. Parents or neighbors may be helpful.

Lesson Seven - Population and Energy 1 day

Behavioral Objectives - After completing this lesson, the student should be able to:

1. Describe the effect of increasing population on energy use and resources.
2. Express ways that energy needs are greater for larger families than for small families.

ACTIVITY ONE - Examine the chart and read the related facts.

Growth of the Worlds Population

Year	Population (10^9)	Yrs. to double
(1)A.D.	.25	1650
1650	.50	200
1850	1.1	80
1930	2.0	45
1975	4.0	35
2010	8.0	?

FACT 1: In 300 years the U.S. population grew to 100 million. It took 50 years more to grow to 200 million. It is estimated that it will take 40 more years to grow to 300 million.

FACT 2: The earth's population grows 66 million each year.

FACT 3: The rate of increase of the worlds population is declining.

FACT 4: The U.S. is a leader in population control.

FACT 5: Increasing population leads to (a) greater future energy needs, (b) greater need for energy conservation, (c) more rapid energy resources depletion.

ACTIVITY TWO - Estimate the cost of energy in your home for a month. Include at least the (1) electric bill, (2) gas bill, and (3) cost of gasoline estimated for family cars. If you don't know and can't find out, use these for a typical family of five: electric - $46.86, gas - $43.21, Gasoline - (3 cars) - $44.00 Calculate the energy cost for one year. In twenty years this family could double in number. Don't

Activity 2, (cont)

consider any increase in price or use and find the cost for two families. Is this a 50 percent increase, a 100 percent increase, or a 200 percent increase? Do you think fuel prices will be the same in twenty years? Would you guess that energy costs will double (100% increase) as they have in the past 20 years? Using that increase, find the estimated cost for two families in 1998.

ACTIVITY THREE - Family size may not be a true indicator for comparing home energy costs. As an example, a home must be heated whether it houses a couple or a couple with four children. Make a list of the energy users in a home that will vary directly with the number of people in the household. An example would be a hair dryer. Ten items on your list would be easy, fifteen a little more difficult, and twenty users would be fairly tough.

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Factsheet - ERDA, Technical Information Center, P. O. Box 62, Oak Ridge, TN 37830

Citizens Workshops on Energy and the Environment Handbook - Office of Public Affairs, Communications Services, U.S. Department of Energy, Washington, DC, 20585

Energy Conservation Program of Montana Cooperative Extension Service, Cooperative Extension Service, Montana State University, Bozeman, Montana 59717

Nebraska Energy Office, P. O. Box 95085, Lincoln, NE 68509

1. large number of brochures
2. Film - "When the Circuit Breaks"
3. Film - "Saving Home Energy"
4. Film - "Project Conserve - S. Dakota Residential Home Energy"
5. Film - "Cap in the Gap"
6. Film - "All About Insulation"
7. Energy Activities for Junior High Science

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Nuclear Power Information Folder, Nebraska Public Power District, 1414 - 15th St, P. O. Box 499, Columbus, NE 68601

Science Activities in Energy - Solar Energy , American Museum of Atomic Energy/Oak Ridge Associated Universities, P. O. Box 117, Oak Ridge, TN 37830

Tips for Energy Savers, Energy Conservation NOW, Pueblo, CO 81009

List of Publications, Conservation and Survey Division, University of Nebraska, 113 Nebraska Hall, Lincoln, NE

** All above materials are free, but should be requested on school letterhead. Much information is also available from your local gas company, electric service, bulk fuel plants, and education service units.

AM I THE WAY?

SOLAR ENERGY

Grade Level: Junior and/or Senior High

Recommended Subject Area: Social Studies, Home Economics

Time Requirement: Five days

by
Lana Tietjen
Judy Williams
Carolyn Cook

Prepared for
The Nebraska Energy Office

Abstract--

Americans are extensive users of the world's total energy supplies. The main purpose of the unit is to create an awareness of the American attitude toward the rapidly depleting supply of fossil fuels. Establishment of individual attitudes toward solar energy as an alternative energy source is the second purpose. The packet deals with general energy knowledge with some emphasis on solar energy and its application to food cooking and preserving. The follow-up unit includes the lab activities such as construction of solar cooker and dryer, recipes, and sun tracking exercises.

Recommended Level--

Junior high and/or senior high in areas of social studies, home economics, and science.

Time Required--5 days

Major Teaching Strategies--

1. Lecture
2. Student discussion
3. Film
4. Brainstorming
5. Group research
6. Attitude clarification

Essential Advance Preparation--

1. Film projector
2. Screen
3. Film - "A Thousand Suns"
4. Film - "The Energy Dilemma"
5. Four Teacher Fact Sheets - included in packet
6. Attitude Survey - included in packet
7. Bulletin Board - Construction (Attachment #2 in unit)

Goals--

1. Make each student aware of his attitudes towards the energy situation.
2. Expose the American attitude of extensive energy use from rapidly depleting resources.
3. Expose the need to conserve energy and use alternate energy sources specifically solar.
4. Provide knowledge for cooking and preserving food by solar energy.

Behavioral Objectives--

When completed, the student will be able to:

1. Identify their individual attitude toward today's energy situation.
2. Compare their energy attitude with that of others.
3. Define the word "energy".
4. Define the word "solar energy".
5. Identify uses of solar energy.

Classroom Activities-- (each activity covers one day)

Activity #1: Using the teacher fact sheet #1 for basic energy knowledge, a short lecture should be given to establish an energy knowledge, a short lecture should be given to establish an energy atmosphere in the classroom. Present the energy attidinal survey (attachment #1 in unit) to allow each student to view his own attitude toward the energy situation. Tally the class results and discuss class attitudes. At the end of the class period, each student should take enough surveys for each adult in the household to complete the night. Remind the students to bring the completed surveys to class the next day to add to the survey. You may wish to have students take additional surveys with them to survey other groups of people--such as, teachers, other high school students, junior high students, upper grade school students.

Activity #2: (a) View the film "A Thousand Suns" - 10 min.-color-1974. Description of film: Lyrically photographed essay arguing that U.S. culture, based on overconsumption and waste, is squandering the world's energy resources. Reflects upon our inverse values--how we are taught to consume, to equate happiness with material things, and to measure ourselves by what we possess. Pleads for a more ecologically oriented life-style.

(b) The returned adult surveys should be tallied. If additional surveys have been completed with other groups--tally each group separately to compare the result of each group to the students' own survey results. Hold a discussion to compare the adult attitudes and student attitudes toward the energy situation. Suggestions on the use of the results of the surveys may include printing the results in the school newspaper or surveying the teachers and administrators for a comparison of their opinions to the students.

Activity #3: (a) View the film on energy problems, "The Energy Dilemma: - 18 min.-color-1974. Description of film: The energy crisis is purely a matter of people increasing in number and demanding higher quantities and quality of goods and services. Predictions for the next decade are for twice the solution may be to limit our energy appetite--use less; demand less. But are we prepared to?

(b) Lecture on "The Energy Problems of Today". A guide for teacher use is included as fact sheet #2.

(c) Have students bring in newspaper or magazine articles on energy issues for classroom discussion.

Activity #4: (a) Lecture on "Solar Energy as an Alaternative Form of Energy". A guide for teacher use is include as fact sheet #3. If time permits, include class discussion which may include the questions stated on the fact sheet.

(b) Hold class discussion. Have students predict lifestyle changes that solar energy could bring about which would affect personal values and goals, family, and goals, family, and their home. Discuss the pros and cons of the student's predictions--beneficial or harmful for the nation and as individuals.

Specific examples--

(1) One day in the lifestyle of a pioneer family utilizing solar energy.

(2) One day in the lifestyle of a family of year 2000 utilizing solar energy.

(3) Landscaping the yard for solar energy home.

(c) If possible, set up a tour of solar homes or buildings in your area.

Activity #5: (a) Lecture on "Utilization of Solar Energy for Food Cooking and Preservation". A guide for teacher use is included as fact sheet #4. (b) Discuss student's attitudes toward this use of solar energy. This activity could easily be a lead into the next unit which includes the laboratory exercises on solar cookery. Preservation, and sun tracking. (c) Have students construct a menu for one meal using no means of energy other than solar!

ATTACHEMENT #1

ENERGY ATTITUDE SURVEY

1. Do you believe there is an energy shortage? ___yes ___no ___don't know

2. Do you believe you have been given a realistic picture through the media of the energy situation facing the United States? ___yes ___no ___don't know

3. Do you believe most Americans are energy "wasters"? ___yes ___no ___don't know

4. Do you believe most Americans are energy "conservers"? ___yes ___no ___don't know

5. Do you believe Americans are reluctant to take responsibility for the future of energy? ___yes ___no ___don't know

6. Do you believe it is the responsibility of every U.S. citizen to conserve energy voluntarily? ___yes ___no ___don't know

7. Do you believe Americans will conserve energy only when government controls are imposed? ___yes ___no ___don't know

8. Would you be willing to change your standard of living to conserve energy? ___yes ___no ___don't know

9. Do you believe you as an individual can make an impact on energy consumption? ___yes ___no ___don't know

10. Would you conserve energy to save money? ___yes ___no ___don't know

11. Do you think the money saved is worth the inconvenience of conserving energy? ___yes ___no ___don't know

12. Do you think the energy saved is worth the inconvenience of conserving energy? ___yes ___no ___don't know

13. Do you feel technology will "bail us out" of the energy shortage? ___yes ___no ___don't know

14. Do you feel you have any input or participation in the energy usage decisions made by your family? ___yes ___no ___don't know

15. Are you going to do something to save energy? ___yes ___no ___don't know

ATTACHMENT I

ENERGY ATTITUDE TALLY

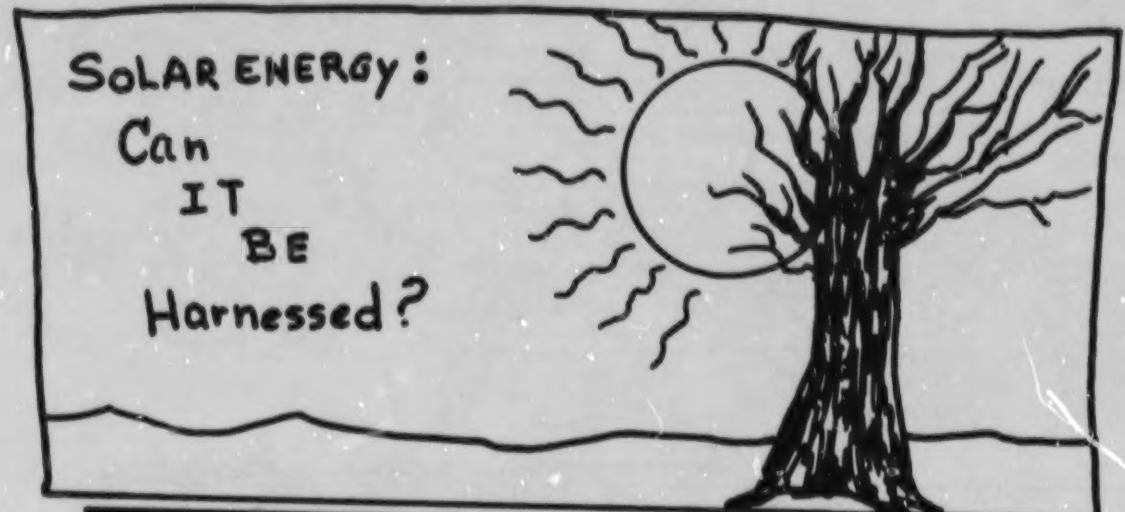
ENERGY ATTITUDE TALLY

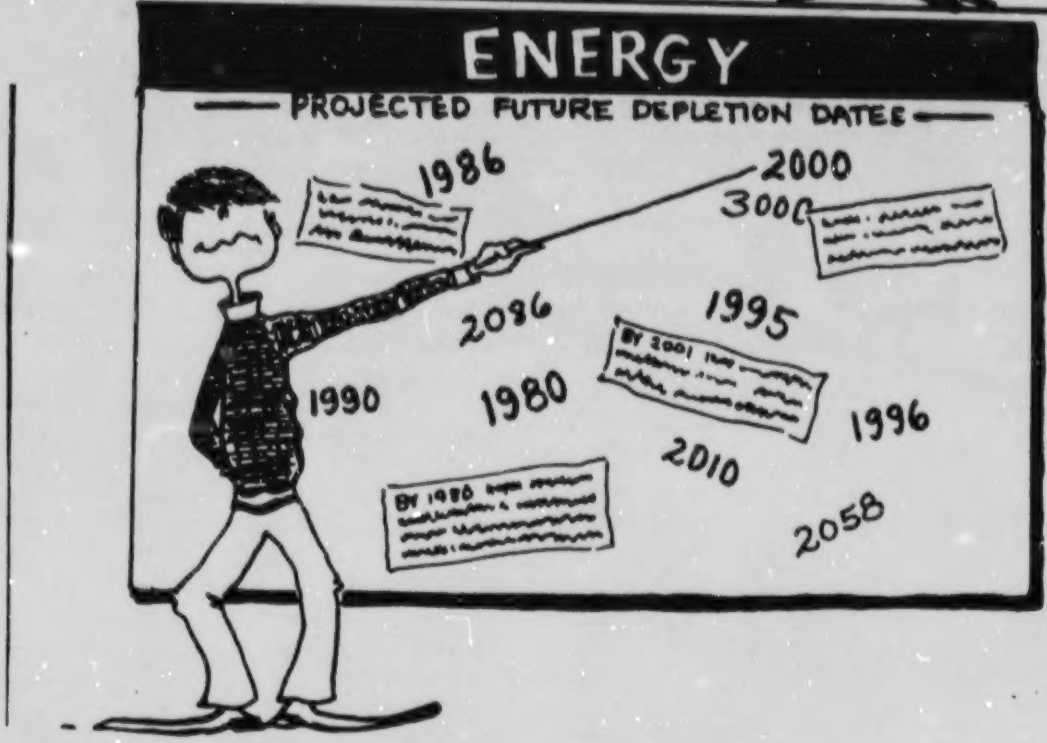
Question	Yes	Percent	No	Per-cent	Don't Know	Percent
1 2 3						
4 5 6						
7 8 9						
10 11 12						
13 14 15						
Additional questions						

Find the percentages for each response. For example: if on question 1 200 students respond; 100 say yes, 60 no and 40 don't know then the percent saying yes is $\frac{100}{200}$ or 50%; saying no is $\frac{60}{200}$ or 30%; saying don't know is $\frac{40}{200}$ or 20%. (You may choose to use a claculator, especially if large numbers of students respond).

ATTACHMENT 11

BULLETIN BOARD IDEA:


SOLAR ENERGY:
Can IT BE Harnessed?


ENERGY
PROJECTED FUTURE DEPLETION DATES
1986
2000
3000
2086
1995
BY 2001
1990
1980
1996
2010
BY 1980
2058

Fact Sheet #1 Energy

The use of energy is so basic to all our life-styles that we have come to take it for granted. We have only recently begun to realize the economic, social and environmental implications of energy resources and usage. A major motivating force for conserving by individuals since the 1973 oil embargo has been "saving money". Unfortunately, few people are aware of the underlying need for conserving energy resources. Conserving energy is not meant just to make our utility bills go down. It means providing future energy needs for our children's society so that they will be able to enjoy a comfortable life-style just as we have. It is time, then, for us to make the transition from economic expedients to intelligent energy ethics. Such a change is not possible without changes in attitudes, decision-making methods, and lifestyles. Such a change is possible through conservation without curtailment . . . if we start now!

It is almost impossible to pick up a magazine or newspaper today and not read about energy. Many products are also being advertised with a new energy terminology such as the ER (energy rating) on air conditioners.

Though not easily defined, energy is not easily ignored. Eyes respond to light energy. Sound energy is detected by the ears. Other nerves indicate contact with thermal and electrical energy. These energy forms are exchangeable and interconnected; different forms of energy can serve the same purpose. Energy can be transformed or stored. The most important and common characteristic is energy's capacity for doing work.

BASIC ENERGY QUESTIONS:

WHAT IS IT? The commodity which gives us the capability to do mechanical work or to produce a change in temperature (that is, to heat or to cool).

WHAT FORM DOES IT TAKE? Energy can take many forms, such as temperature difference between two objects ("heat energy"), the flow of electricity ("electric energy"), and mechanical motion ("kinetic energy"). "Potential energy" is mechanically stored energy, such as water stored behind a dam or the tension in a spring, or chemically stored energy found in fuel.

WHAT IS THE RELATIONSHIP BETWEEN ENERGY AND POWER? Power is the rate at which work is done or energy is used.

WHERE DOES OUR ENERGY COME FROM: Today, most energy is derived by burning fossil fuels (release of stored chemical energy). Fossil fuels include natural gas, petroleum, coal, tar sands and oil shale. Coal includes various types which are: anthracite, bituminous, lignite, and brown coal. Fossil fuels are produced through biological processes which are modified over millions of years by geological processes. Energy is also supplied by flow of water, nuclear processes, the muscles of man and animals and wood.

HOW DO WE USE ENERGY IN OUR DAILY LIVES? Energy is used to warm or cool our homes, provide light, operate machinery in factories, mobilize vehicles, and process raw materials into finished products.

HOW IS ENERGY MEASURED? There are many ways to measure a systems energy content. Some ways of measuring include: measuring the temperature increase produced in water, or measuring the current, voltage and period of flow of electricity, or measuring the speed and weight of an object.

HOW DO WE SPECIFY AMOUNTS OF ENERGY? A variety of equivalent units can be used to express quantity of energy. They can be applied to mechanical, electrical or heat forms of energy. Some of the most widely used units are:

British Thermal Unit (BTU) -- One BTU is the energy required to increase the temperature of one pound of water by one degree Fahrenheit.

Kilowatt (1,000 watts) -- a unit of electrical power indicating the rate at which electrical energy is being produced or being consumed.

Kilowatt-hour (1,000 watt-hours) -- the unit of electrical energy equal to the energy delivered by the flow of one kilowatt of electrical power for one hour.

COMMONLY USED ABBREVIATIONS

bbls - barrels (a barrel contains 42 gallons)
kw - kilowatt
kwh - kilowatt-hour
mcf - 1,000 cubic feet (of gas)
Mw - megawatt, 1 million watts
Btu - British Thermal Unit
Therm - a unit of energy used for natural gas equal to 100,000 BTU

Energy Problems of Today

Fact Sheet #2

It is virtually impossible to characterize the American people, but one thing that most everyone in the U. S. has in common is a reliance upon a tremendous amount of energy for our daily lives. Americans are consuming a great deal of the earth's energy resources when compared to the rest of the world. The U. S. consumes almost one-third of the world's energy supply although this country has only 6% of the world's population. The U. S. consumes more energy than West Germany, Japan, Great Britian, and the U. S. S. R. combined.

People basically use energy in two ways: to earn their living, and to enjoy the living they have earned. When a country's energy usage is examined, one can usually find a strong relationship between the use of energy and economic affluence. The U. S. has a very high standard of living. As Americans examine what has happened to the supply of energy in this country, it appears our use of enjoying what we have earned has gotten out of hand.

> "to maintain the average American at present comfort levels requires 21,600 pounds of non-metal resources such as sand gravel, salt, 1,450 pounds of metal substances and 18,600 pounds of fossil fuels, a little less than than one ounce of uranium each year. That amount of energy, nearly twice what the average European uses in a year, is the equivalent of each citizen having 300 slaves working 24 hours a day."

Americans are starting to have to pay the price for being an affluent nation. In the past, energy has been an inexpensive commodity in the U.S., but this has begun to change dramatically. The price of environmental clean-up, fuel scarcity, inflation, and the rise in energy production costs have forced prices up.

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[1] Clark Wilson. "It takes Energy to Get Energy: the Law of Diminishing Returns Is in Effect," Smithsonian, Dec., 1974, pp 86-87.

There are many hard facts which will have to be faced by every American:

1. Global energy use has been increasing faster than the population. The world population has doubled in the last thirty years, but the world energy use has doubled in the last ten years.
2. The U. S. has the highest rank in use of energy on a per capita basis. It should be noted, however, that many products produced in the U. S. that require the use of energy are made available to other nations.
3. A sizeable proportaion of the energy used in the U. S. goes into food related activities. An increase in crop yields has been brought about through increased inputs of energy in the form of machinery, gasoline, labor, fertilizers, herbicides, insecticedes, irrigation, etc. In addition, another 10%-12% is used for processing distributing, and preparing food.
4. Although the developing nations use less of the world's energy resources per capita than the U. S. about 60% of the total energy used in developing nations goes into food production and preparation. For the entire world, this figure is 25%. Yet, despite these heavy energy inputs world food demand still exceeds world food production, and both food and energy demands are likely to continue to increase. Effective decision-making in world food problems must take into consideration the energy needs and resources and types of energy involved in food production.
5. The U. S. currently has a limited amount of energy supply available to us, and we can fairly well predict where our energy resources are going to come from in the future.

6. Development of new energy sources or the construction of new facilities for producing more cannot happen overnight.

All of these facts do not mean that the lights will go out tomorrow from a massive power shortage or that no one will be able to buy gasoline for the family car. However, we have begun to feel the effects of this situation, and we must take some action to slow down our energy consumption.

ENERGY STRATEGIES

Several broad strategies can be used singularly or in its entirety to resolve our energy problems.

Strategy 1: Develop an energy economy not based on fossil fuels.

Strategy 2: Develop "successor sources" to replace oil and gas over next several years.

Strategy 3: Increase the efficiency of energy generation and use.

Strategy 4: Change from a "disposable" to a "durable" society.

In the future, nuclear, solar, coal, geothermal, and other energy resources can be developed to replace fossil fuels. The technical challenges, time, and capital, will be required. At the present time, "strategy 2" is recieving the overwhelming attention and committment of government and industry.

"Strategy 1" and "Strategy 2" are similar. Both require the same government committment. But "Strategy 1" forcloses the use of coal because it pollutes. This strategy emphasizes the development of fission and fusion as well as solar energy resources. This strategy would require a long lead time.

"Strategy 3" can "trim the fat" off current energy generation and use over the short run and saves money. Over the long run, efficiency can be increased by perhaps 50 percent, saving even more money and fuel.

"Strategy 4" concentrates on overall energy use patterns rather than specific methods. It suggests that the American society can change from a high energy to a lower energy-consuming society. Changes in behavior would have to come about possibly requiring the taxing or rationing of resources in order to slow the consumption rate of materials and energy.

Strategies 1, 2, and 3 can be implemented by professionals through research and development. Citizens can implement strategies 3 and 4 through the wise use of energy. Conservation is the only viable solution for the immediate future.

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[4] Energy Conservation in the Home.

[7] Citizen Action Guide to Energy Conservation.

[2] Introduciton to World Food Problems.

Teacher Fact Sheet #3

The Sun as an Alternate Method of Energy

Solar energy has directly or indirectly provided all the energy for the earth since its creation.

All plant and animal life including man on the earth has depended on the sun's energy for existence. The sun's rays have provided the heat necessary to maintain the temperature required for human, animal, and plant survival.

There are two disadvantages of solar energy. The sun's energy is intermittent. The sun shines only on non-cloudy days and, therefore, its energy must be stored. Also, the sun's energy is diffuse. Because it spreads out very thinly, it must be collected by some means since only a small amount arrives at one place. If devices can be constructed to either collect this diffuse energy over a large area/ or store large quantities of energy then tremendous quantities could be made available as an alterate source of energy. Thus, many efforts are now underway for the storage research and development of solar energy.

Mankind has used solar energy for thousands of years. Winds which are produced by unequal amounts of solar energy falling in different geographical locations have been used by man since the earliest recorded history. Solar energy has been used to generate electricity, and simply as heat for warmth or cooking by using the sun's direct heat rays. Possibilities of using solar energy to produce high quality fuels have now been suggested.

Solar energy offers many advantages. The cost of the rays of the sun is zero. Sunlight is inexhaustible compared with almost all other known available energy sources. It is a clean "fuel" and even though the amount reaching the ground may vary, it is constant as it arrives in the vicinity of the earth.

Questions for discussion:

1. Is the goal of mankind now to develop a greater variety of applications of solar energy?

2. Do scientists need to develop through technology better ways to more effectively use solar energy for the benefit of mankind?

3. If our supplies of oil and natural gas are being rapidly depleted will it be necessary to develop other possible sources of energy such as coal, nuclear, geothermal, and solar?

References [1] Solar Energy, William Eaton, pamphlet, Energy Research and Development Administration, Office of Public Affairs, Wash. D. C., 20545, 1976. Free from State Energy Office.

Teacher Fact Sheet #4

Utilization of Solar Energy for the Cooking and Preserving of Foods.

Preserving food by drying through the sun's direct rays is the oldest method of food preservation. Sun drying of fruits and vegetables was practiced before biblical times by Chinese, Greeks, Persians, Egyptians, and Hindus. In recent years it again has regained considerable popularity. Even though drying is not difficult, it does take constant attention, skill, time, and understanding of the principles of food drying methods. Drying requires little outlay of money or equipment. It is economical because it does not require jars, sugar, and other materials commonly used in other methods of preservation.

During the drying process three situations must be controlled:

1. Denaturation or inactivation of enzymatic systems in the fruit or vegetable.
2. Removal of enough moisture to prevent spoilage. If the temperature is too high or the humidity too low, there is a danger of moisture being removed too fast. This causes a hardening of the outer cells of the product and prevents water vapor from diffusing from the inner cells.
3. Reducing the water content to control the microbial growth. Microorganisms which grow rapidly on fresh or raw fruits can be controlled during drying. Sun drying is the evaporation of water from products by sun or solar heat assisted by the movements of surrounding air. To be successful, there must be a rainless season of bright sunshine that coincides with the time of product maturity. Sun drying requires considerable care. Products must be protected from insects and must be sheltered during the night. This method is relatively slow, because the sun does not cause rapid evaporation of moisture.

Information available from "Home Drying of Fruits and Vegetables."

EVALUATION

1. Have the students write a short paper comparing the student's individual energy attitude and the results of the adult energy survey. This could easily be given as an outside assignment at end of Activity 2 and given one or two days to complete.
2. Have the students write a short paper answering one of the four following questions at the completion of the unit. Paper should include student's personal views, basic knowledge gained from the unit, and "outside" information from magazines, books, newspapers, etc.
   - A. Is there an energy shortage in the United States today?
   - B. Are the American people today labeled as energy "wasters" or "conservers"?
   - C. Will future technology "bail us out" of the energy shortage?
   - D. Has a realistic picture of the energy situation facing the U. S. been given to the American people by the news media?
   - E. Will solar energy be the energy source in the U. S. by the year 2525?
   - F. Will the average American family by the year 2525 use solar energy as the main source of "fuel" for the cooking and preservation of food?

RESOURCES

1. Solar Energy, William W. Eaton, pamphlet, Energy Research and Development Ad., Office of Public Affairs, Wash. D. C. 20545, 1976. Easily accessible through Nebraska State Energy Office, 301 South Centennial Mall, P. O. Box 95085, Lincoln, NE 68509.

2. Introduction to World Food Problem-Must We Eat Less? Sivasailen Thiagarajan and Diane D. Dormant, Manual, University of Mid-America, p. 53, 1977.

3. Drying Foods at Home, Martin W. Miller, Frank H. Winter, George K. York, Bulletin, U. S. Department of Agriculture, Home and Garden Bulletin #217, January, 1977, U. S. Government Printing Office, Washington, D. C. 20402.

4. Energy Conservation in the Home, Curriculum Guide, U. S. Department of Energy, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee, 37830. 1977.

5. A Thousand Suns, Film, Barr Films, 3490 E., Foothill Boulevard, Pasadena, California, 91107, 213/793-6153, 10 minutes, color, 1974, Rental: $22.50.

6. The Energy Dilemma, Film, Films, Inc., 5625 Hollywood Boulevard, Hollywood, California, 90028, 213/466-5481, 18 minutes, color, 1974, Rental: $20.00.

7. Citizen Action Guide to Energy Conservation, Book, Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, N. W., Washington, D. C., 20006, 1973.

SUPPLEMENTS

The Coming Age of Solar Energy, D.S. Halacy, book, Harper and Row, Inc., New York, N.Y., 10022, 1973, $7.95.

Direct Use of Sun's Energy, F. Daniels, book, Ballantine Books, Inc., Westminster, MD. 21157, 1964, $1.95.

Sun Power: An Introduction to the Applications of Solar Energy, J. C. McVeigh, book, Pergamon Press, Elmsford, N.Y., 10523, 1977, $4.95.

Energy We Can Live With, D. Wallace, book, Rodale Press, Emmaus, Pa., 18049, 1976, $3.95.

Energy For Survival, W. Clark, book, Doubleday and Co., Inc., New York, N.Y., 11530, 1974, $4.95.

Home Drying of Fruits and Vegetables, Flora H. Bardwell and D. K. Salunkhe, EC 332, Extension Services, Utah State University, Logan, Utah, 84322.

PETROLEUM IN AGE OF SCARCITY

Recommended Level: Senior High Social Studies
Time Required: 16 days

by
Richard Linder

Prepared for
The Nebraska Energy Office

UNIT: Petroleum in an Age of Scarcity

OVERVIEW:

In general the purpose of this unit is to examine the problem of scarcity in the relationship between our geographic environment and our social/historical development. More specifically this unit is an examination of the "Energy Crisis" as it relates to the problem of scarcity. In addition, this unit attempts to examine the scarcity of energy in relationship to national development and policy and international relations. This unit deals primarily with petroleum and natural gas because of their close geographic and geologic relationship, and their critical role in modern industrial and agricultural development, their growing and critical scarcity in relationship to that development, and their growing political role in world affairs.

This unit deals with four basic areas. (1) Energy in History, which develops a brief picture of man's development of energy, especially the relationship of this development from a political and economic point of view. (2) The Geography of Oil, which presents a picture of current petroleum usage, resources, and reserves. (3) The Politics and Economics of Oil Today--The Energy Crisis in World Affairs (4) The Future: Conservation and Alternatives, which deals with the social consequenses of the energy crisis and the choices we have as a society in dealing with the energy shortage.

It might be asked, "Why a unit on international relations in regards to energy?" It also might be asked by students and teachers, "Is this really important to our understanding of the energy issue"? Simply answered one might say that when we of the United States run out of energy, so does everybody else. Likewise our friends and foes alike are more than just a little concerned about our excessive use of energy--especially in regards to our waste and misuse of energy resources. This is often viewed, especially by the Lesser Developed Countries, as a hindrance to their own development. The simple fact is that there is only so much energy producing resources in the world and we of the United States use more than 30% of these resources while our population makes up only 6% of the total world population. It then becomes distressing to both the developed and underdeveloped nations that we speak of equality and human rights while we waste much of our energy and the vast majority of the world struggles to survive.

As teachers, we must realize that we have entered a new age--not an age of abundance, as it seemed in our recent past, but an age of scarcity. Scarcity in the forms of food, fuel, and fiber, as well as many other industrial-related resources, have been reported with increasing frequency. This new age has seemed to come upon us like a thief in the night, bringing with it starvation, inflation, fuel shortages, economic disorganization, and political chaos. Yet, if we think for a while, we would find that the Age of Scarcity is in fact an old traveling companion within the entire framework of human history. The realities of history show us that scarcity has always been with us which is why natural resources, human resources, and capital have always had a value in an economic sense.

As teachers we are faced with the responsibility of presenting our students with the problems facing us in this age of scarcity, not only as citizens of the United States, but also as members of the world community. This is the point of real challenge. It is not easy to convince a student that his or her actions in regards to use and conservation of energy will in effect influence world events. For example, the excessive use and waste of petroleum products in our automobile makes us, as our own national supplies disappear, more and more dependent on less politically and economically reliable sources of petroleum. How can we convince a student to use his or her car less, obey energy related speed limits and so forth when (1) we don't believe or do it ourselves and (2) the entire society has become so speed and automotive oriented that the idea of doing without or with less has become almost an impossible request.

To state again the purpose of this unit in another fashion, we as teachers, must make our students more aware of his/her position in both this country and the world as it relates to energy usage and waste in the complexity of world affairs.

RECOMMENDED LEVEL: Sr. High School. This unit can be applied to Geography, Social Problem related courses, American and World History, Global and Cultural Studies, Economics, and Government. Possible use in Science Courses might be possible with some modifications.

TIME REQUIRED: 16 days

TEACHING STRATEGIES: Several strategies could be used and adapted by the teacher to fit his or her own style and preference. The major strategies included in this unit emphasize (1) group and individual research since no textbook is used, (2) class discussion within the framework of that research, and (3) inquiry to promote and encourage further research by the student. In short, let the student find answers, and for that matter, more questions. Also some attitude and value clarification and skill development can be carried out. Lecture could also be used, especially for introducing topics, bringing in new and hard-to-find information, or for directing the students toward particular goals and objectives in their research or discussion. The amount of lecture is left to the teacher and his/her own preference.

ESSENTIAL ADVANCE PREPARATION: As a teacher dealing with the energy crisis one will become aware of the tons of scientific and technical data, often conflicting facts and opinions, and the ever changing events in national and international affairs which relate directly and indirectly to the energy issue. Preparation should, as in all teaching areas, include a good basic knowledge of the overall situation. This should include an awareness of other energy related areas besides oil.

OTHER PREPARATION:

1. Audio-visual equipment:
    a. Filmstrip projector and cassette recorder
    b. Video-tape machine and TV

2. Two World Desk Maps per student
3. Colored pencils or pens, enough for student use within the classroom
4. Any paper and other materials which the teacher deems necessary for the class
5. Access, either in the classroom or in the library, to reference material
6. Access to current newspapers or magazines either in classroom or the school library

GOALS:

1. The student will be aware of his/her own role in the complexity of world and national affairs as a citizen of this country and as a member of the world community.

2. The student will show an understanding of the energy issues as it relates to the consumer.

3. The student will understand the interrelationship of energy usage and waste and the depletion of energy resources and other non-renewable resources.

4. The student will display an ability to analyze facts and ideas concerning the energy issue and draw his/her own conclusions about the energy issue.

5. The student will demonstrate an ability to discuss an issue in an open and intelligent manner utilizing facts he/she has developed from research.

OBJECTIVES:

1. The student shall display a general knowledge of man's energy usage through history via an objective test.

2. The student will interpret man's usage of energy through history in relationship to his/her political and economic development in written essay and classroom discussion.

3. Each student will construct a working definition of energy and apply that definition to modern social development in classroom discussion.

4. The student will be able to list other non-renewable resources besides oil, and how these resources relate to our ecosystem.

5. The student will construct a map showing the major oil producing regions of the world and their relationship to major oil consuming areas of the world.

6. The student shall analyze and then discuss their findings in the geographic significance of the world oil resources and reserves and energy usage.

7. The student shall rank the major uses of that energy in the United States and discuss this usage in relationship to the energy crisis.

8. The student shall compare the energy usage of the U.S. and the developing world and describe the effect of this usage on the developing world.

9. The student will outline the importance of petroleum to the Lesser Developed Countries of the world and present their arguments for a more fair and equitable system of distribution of all economic resources, but especially energy resources.

10. The student will discuss and interpret the effect of the 1973 Oil Embargo on the economies of the developed and the Lesser Developed Countries of the world.

11. Each student will develop through research a plan for coping with the energy shortage in petroleum by utilizing various means of conservation and alternative energy resources.

DAILY LESSON PLANS:

LESSON PLANS: Days 1 and 2--Energy in History

The first days are spent primarily in the examination of the history of energy usage and development. It would be easy to spend a great deal of time in this area in relation to world history but that is not the purpose of this material. The primary purposes are to (1) introduce the student to the concepts of energy usage and the development of civilization, and (2) to illustrate the relationship of energy to the advancement of civilization. Keep in mind that this section is primarily an introduction to energy and its relationship to mankind.

This material could possibly be presented in three ways, as long as one does not spend more than two days. Lecture would be a way of presenting concise and uniform information. Students could also work on notetaking and listening skills. A general outline of what should be covered is provided below. A second method is to provide the students with the worksheet (Activity Sheet #1) which should be provided before the 1st day as a home work assignment and then discussed in class. Grading would be optional. The third means would be to use both the lecture and the worksheet in a kind of inquiry or discussional exercise.

TEACHER PREPARATION:

1. Research and prepare lecture
2. Prepare student activity sheet

TEACHER LECTURE OUTLINE: Energy in History

- I. Energy in Pre-History
  - A. The Age of Muscles--Primary energy source from food
    - 1. The primitive hunters and gatherers
    - 2. Primitive agriculture
    - 3. First use of animals--the horse, ox, camel, water buffalo, and dog
  - B. Fire--First inanimate form of unlocked chemical energy
    - 1. Source of heat and light
    - 2. The kiln and pottery
    - 3. The beginning of the Age of Metals--Copper, Bronze and Iron
- II. Energy in Ancient History
  - A. Mesopotamia
    - 1. The wheel
    - 2. The sun for building brick--the cities of Ur and Babylon and the Ziggurats
    - 3. The rivers and irrigation
  - B. Egypt
    - 1. Pyramids and temples--the power of human labor
    - 2. The power of the Nile river--irrigation and transportation
  - C. The Phoenicians--Wind and trade
  - D. Greece and Rome (and other civilizations)
    - 1. The human slave
    - 2. Science and technology
      - a. The Greeks "Simple Five"--the lever, the wheel and axle, the pulley, the incline plane, and the screw
      - b. Archimedes
      - c. Roman engineering and homes with hot water
      - d. Chinese (Chou Dynasty) and water power for silk weaving, bellows furnaces and forges, and (Tang Dynasty) gunpowder
- III. Between Rome and the Industrial Age
  - A. Serf and slave
  - B. The Renaissance--Age of Wind and Water
    - 1. The visionaries of the future--Roger Bacon and Leonardo da Vinci
    - 2. Wind and Water--the birth of industry
- IV. The Industrial Age
  - A. The Age of Steam and the advent of coal
    - 1. Thomas Newcomen
    - 2. James Watts
    - 3. Richard Arkwrights
    - 4. James Hargreaves
    - 5. Richard Trevithick
    - 6. George Stephenson
    - 7. Abraham Darby
    - 8. Henry Bessemer
  - B. The Age of Electricity
    - 1. Defining electricity--Pieter Van Musschenbroak, Benjamin Franklin, Alessando Volta, and others

2. Producing electricity--Michael Faraday and Humphry Davy
3. "And the lights came on." Thomas Alva Edison and Nicola Tesla
4. The Age of Communication--Alexander Graham Bell and Samuel Morse

C. The Age of Petroleum
1. Ancient usage
2. Colonel E. L. Drake
3. The Automobile
a. J. B. Dunlop
b. Gottlieb Daimler
c. Henry Ford

D. The Age of Nuclear Power
1. World War II
a. German efforts
b. Albert Eistien and the Manhattan Project
2. Enrico Fermi--Nuclear Power as an energy source

V. Energy Today
A. Environmental concerns
1. The Ecosystems
a. Energy use and pollution
b. Energy use and health
2. Energy Use and Politics--The Energy Crisis
a. The Middle East and Oil
b. Introducing the Age of Scarcity (At this point it is important to note that energy is not the only problem in the areas of scarcity.)

It is important at this point that the student become aware of the concept of scarcity. Be sure that this point is clear. That is be sure the student is aware of the fact that the growth of civilization means to use and waste energy.

STUDENT ACTIVITY SHEET #1 NAME____________________________

1. To pre-historic man, what was his major source of energy? Why was this source of energy so important? How would the change from primitive hunting and gathering to primitive agriculture improve this source of energy? How would the domestication of animals, such as the horse, ox, camel, water buffalo, and dog aid primitive man in maintaining this source of energy?

2. Exactly how and when fire was first used as a source of heat and light is unknown, although it occurred during the paleolithic period. How would the use of fire improve man's ability to live in a rather hostile environment?

3. How would the development of the kiln improve the manufacture of pottery?

4. How would fire influence the development and use of metals such as copper, bronze, and iron? How would this development change man's ability to cope with his environment? How might this event affect the environment?

5. How might the wheel change the course of energy usage? What was one of the most important uses of the wheel in the Mesopotamian Civilizations?

6. Solar energy was used to build the cities and temples(Ziggurats) of the various Mesopotamian Civilizations. How, in such an ancient culture, could such a statement be true?

7. Why was the control of the Tigris and Euphrates important to the well-being of the Mesopotamian Civilizations? How might these rivers be considered sources of energy for these ancient societies?

8. What was the primary energy resource for the building of the pyramids and temples of ancient Egypt? Could the same resource be considered of equal importance in other ancient civilizations? How about modern civilization?

9. Describe the importance and use of the Nile as an energy resource in ancient Egypt. How has the construction of the Aswan Dam changed the role of the Nile in modern Egypt?

STUDENT ACTIVITY #1

10. What source of energy did the ancient Phoenicians use to trade with the world?

11. Slavery has always been an important source of energy in ancient civilizations and in some modern civilizations. How could slavery be considered an efficient source of energy? How could slavery be considered an inefficient source of energy? Cite examples of each from the experiences of ancient Greece and Rome.

12. The Greeks were among the first to utilize science and technology as a means of enhancing energy to make it more efficient. They called this technology the "simple five". Name the "simple five" and explain how these could be used to enhance the efficiency of energy. What was Archimedes' contribution to this system and why was it important?

13. The Romans took much from the Greeks in the way of technology and improved upon it. In what ways did the Romans find new uses and applications for energy consumption?

14. In what ways did ancient China improve on the use of energy?

15. During the Middle Ages in Europe much of the energy used was human and animal muscle. Why was serfdom a method of using the energy more efficiently? Was this system much different than slavery?

16. Who were Roger Bacon and Leonardo da Vinci? How did they see the future in regards to using energy? Why didn't their ideas work during the Renaissance?

17. Wind and water have long been used to produce energy. During the Renaissance, why did these two energy sources become more important? How did these two sources of energy contribute to the industrial revolution?

18. The Industrial Revolution came with the advent of the steam engine and the extensive use of coal. Below is a list of important personalities who contributed to the use of steam and coal in the industrial process. Describe how each contributed to the Industrial Revolution.

a. Thomas Newcomen

STUDENT ACTIVITY #1

b. James Watts

c. Richard Arkwrights

d. James Hargreaves

e. Richard Trevithick

f. George Stephenson

g. Abraham Darby

h. Henry Bessemer

19. What did the following individuals do to introduce electricity as a major source of energy?

a. Pieter van Musschenbroak

b. Benjamin Franklin

c. Alessando Volta

d. Michael Faraday

e. Humphry Davy

f. Thomas Alva Edison

g. Nicola Tesla

h. Alexander Graham Bell

i. Samuel Morse

20. Describe some of the uses for petroleum in ancient times. Who was Colonel E. L. Drake? How did J. B. Dunlop, Nikolaus Otto, Gottlieb Daimler, and Henry Ford influence the future use of petroleum?

21. In what ways did World War II aid in the development of nuclear power? What efforts were made in developing nuclear power in Germany? In the United States? Why was Albert Einstien important in this development? Who was Enrico Fermi and how did he contribute to the development of nuclear energy in peacetime?

STUDENT ACTIVITY #1

22. Energy today is no longer taken for granted, but has raised a number of major concerns. Describe the following concerns as they relate to energy use.

a. Energy and pollution

b. Energy and health

23. In your own words, describe how the concern for energy is related to our concerns in world politics. Why do political events in the Middle East affect oil prices in the United States?

24. Define the word scarcity. How does this definition relate to our current energy situation? Do you believe there is a real energy shortage? Why or why not?

25. Define the following terms and cite examples of each.

a. Renewable resources

b. Nonrenewable resources

26. What renewable resources are considered to be in short supply? If they are renewable, how can there be a scarcity of those items? What nonrenewable resources are in short supply? What has to happen when they run out?

27. What action can one take to protect both types of resources? How is politics and economics related to the problems of scarcity and attempts to protect these resources?

LESSON PLANS: Days 3 and 4--The Age of Scarcity

The primary purpose of this section is to give the student an overall picture of the current situation. Energy and energy shortages can not be placed alone, but must be examined in the total situation. We may turn to alternative energy sources, such as the sun or nuclear, which may last forever, but what good is it if we run out of steel or safe water?

The purpose of this set of filmstrips is to make the student aware of the interrelationship of the energy problem to other areas of scarcity and related issues. The first filmstrip, "The Wasting of Plenty", deals primarily with the problems of scarcity, its interrelationship with oil, and most important, its relationship to uncontrolled growth. Most important, the filmstrip deals with the cause of the problem--us.

The second filmstrip, "The Cycle of Scarcity" deals with the relationship of scarcity to our ecosystems and how it relates to the problem of scarcity. Not only are the ecological effects noted but also the social effects of our growing scarcity.

A third filmstrip in this series will be used later.

TEACHER PREPARATION:

1. Filmstrip: The Age of Scarcity, Filmstrip #1 and 2,
   Westinghouse Learning Press. New York, 1974
   (set of three)
2. Filmstrip Projector and cassette recorder.

MAJOR TEACHING STRATEGIES

1. Preview filmstrip and read teacher's manual.

2. From teacher's manual, or on your own, select questions to ask before the filmstrip is shown.

3. Show filmstrip and have students keep notes or write out discussion questions of their own.

4. Using the questions in the teacher's manual, your own questions, or the student's questions discuss the filmstrip.

5. It is recommended that you do one filmstrip each day.

LESSON PLAN: Days 5, 6, and 7--The Geography of Oil

This section deals with oil and natural gas from the point of production while it gives the student a chance for a little outside research. The student activity provided is short and rather general but should give the student a chance to understand the process of oil development, extraction, processing, and transportation. It will also give the students the opportunity to work in cooperation on this research project.

TEACHER PREPARATION:

1. Divide the students up according to the topics below and have each group develop a report on the subject. Each group should draw a diagram of the process to be placed on the bulletin board to illustrate the overall process.
2. Topics
    1. How oil and natural gas are formed. (Its geologic history)
    2. The search for oil and natural gas. (How geologists look for oil)
    3. Drilling for oil and natural gas.
    4. The oil refinery
    5. By-products of oil and natural gas
    6. Transportation of oil and natural gas
3. Provide students with needed paper and other materials.
4. Provide research materials if necessary. If at all possible let the students work in the library under your supervision.
5. Allow one and one half class periods for research and one and one half periods to give reports.

6. Grading should be based on what each student contributes to his group, the report, and the diagram.

7. Show Video tape "Oil", if time remains.

   a. Video tape machine and television monitor.

   b. "Oil" American Petroleum Institute, 18 minutes
      This will allow students to check their own data
      in a film sequence.

LESSON PLAN: Day 8--Geography of Oil - Where is it?

This day is spent constructing maps of oil producing and oil consuming regions. Emphasize the importance of the use of energy by the developed world.

TEACHER PREPARATION:

1. Two world desk maps per student
2. One atlas per student (if possible)
3. Colored pencils or pens
4. One copy of Student Activity Sheet #2
5. Evaluation of maps based on accuracy of locations and neatness of information given.

STUDENT ACTIVITY #2--Map Work   Name________________________

1. On one of the maps provided locate the following major oil producing states. (Locate, label, and color in as directed)

Red--Members of OPEC (Organization of Petroleum Exporting Countries)

- Algeria
- Ecuador
- Gabon
- Indonesia
- Iran
- Iraq
- Kuwait
- Libya
- Nigeria
- Quatar
- Saudi Arabia
- United Arab Emirates
- Venezuela

Blue--Non OPEC oil producing countries

- Soviet Union
- United States
- Peoples Republic of China
- Canada

Green--New areas of oil production

- North Sea
- Alaska (Since a part of the U.S., draw diagonal lines through the state.)
- Mexico

2. On the second map provided locate the following major oil consuming states. (Locate, label, and color in as directed.)

Red--Major consumers

- United States
- U.S.S.R.
- Japan
- West Germany
- France
- United Kingdom
- Peoples Republic of China
- Turkey
- Netherlands

3. From the two maps, what conclusions might be drawn about the world production and consumption of oil? Better than two-thirds of the total consumption comes from the list above while the Middle Eastern members of OPEC alone produce over one-third of the world total. Explain why this might be significant politically in world affairs.

4. Since over two-thirds of world consumption is found in the list above, how is this significant to the rest of the world, especially the developing nations of Asia, Africa, and Latin America? How might other developed countries react to this situation?

LESSON PLAN: Days 9 and 10--The Politics and Economics of Oil Today--The Energy Crisis. Politics in the Middle East

This and the following lessons are devoted to the causes of the energy crisis. This lesson will be devoted primarily to discussion of the political situation in the Middle East. Be aware, and make sure your students are aware, that the political situation in the Middle East did not create the energy crisis. What created the energy crisis is the simple geologic fact that the earth has only a limited amount of resources, including oil, and these resources will in time disappear or at least become scarce. What the political situation in the Middle East did was to bring this fact home and to force us to examine our energy policy.

In dealing with the energy crisis one must deal to some degree with the Middle East. The problem is that the issues facing the Middle East, separate from the oil, is one of the most complicated issues facing the world today. The problem for the teacher dealing in the area of oil policy is to present the situation in the Middle East as briefly as possible, yet as accurately as possible. It is therefore important that you as the teacher be as informed as possible to the situation in the Middle East so that you can answer questions and create discussion.

TEACHER PREPARATION:

1. Briefly cover the Middle East situation. Lecture/Discussion might work in an inquiry sense. Assign students before class to find out as much as possible about the recent history

of this region. In the lecture/discussion follow the sequence outlined below. Be sure to have the student do as much research as possible.

I. The Creation of the Isreali State
   A. Ottoman control of the Middle East and World War I
   B. British/French Mandate in the Middle East after World War I
   C. World War II and the Holocaust
   D. The Jewish State
II. The 1948 Arab Isteali War--The Palestinian question
   A. The Isreali War of survival
   B. The Palestinian Arabs in exile--The central question
III. The 1956 and 1967 Wars
IV. The Yom Kippur War of 1973
   A. Arab success in war
   B. The weapon of oil--The 1973 Oil Embargo

2. Show filmstrip: *Oil: Global Weapon*. Discuss filmstrip according to teacher's manual. (*Oil: Global Weapon*, New York Times, 1974.)

3. Show filmstrip: *The Arab World: Oil, Power, Dissension*, and discuss the material according to the teacher's guide. (*The Arab World: Oil, Power, Dissension*, Current Affairs Filmstrip, Wilton, Conn. 1976.)

LESSON PLAN: Day 11--The Politics and Economics of Oil Today --The Energy Crisis. American Energy Usage Problem.

American energy usage is unbelievable to many people throughout the world. When 6% of the world's population uses about 30% of the world's energy its only a matter of simple mathematics to realize that 94% is limited to the remaining 70% of the world's energy resources. The purpose of this section is to examine our energy use which makes us, as a nation, vulnerable to world economic and political changes.

TEACHER PREPARATION:

Give each student a copy of Student Activity #3 and have the student work on them for about one half the class period with discussion the second half of the period. The teacher should bring in additional material for discussion.

STUDENT ACTIVITY #3 Name______________________________

Below is a list of facts and statements about U.S. energy consumption. Read the statement and study the fact then answer the questions concerning each statement. The facts are provided from the Dept. of Energy Monthly Review, Dec. 1977, and the Dept. of State Publication 8904, General Foreign Policy Series 304, "The United States and World Energy".

1. STATEMENT: According to a Gallup poll published in June 1977, only 52% of Americans knew their country had to import any oil at all. ADDITIONAL STATEMENT OF FACT: In 1977 the United States imported 47% of its crude oil at a cost of $42,136,458,000 or 29% of the total dollar value of all U.S. imports.

a. What does the statement say about American awareness of the energy problem?

b. In recent years the United States has had much difficulty in keeping its currency value up on the foreign exchange. Considering what we spent on oil in the same foreign market, how would this affect our currency value overseas?

c. Why is this significant to U.S. vulnerability in world political affairs?

2. STATEMENT OF FACT: In 1954 only 8½% of our oil was imported, in 1965 this figure was up to 20%. In 1973 the figure was up to 35% and today it is up to 48%. The figure will pass 50% by 1985.

a. How might such a situation affect U.S. foreign policy today?

b. How might such a situation affect U.S. foreign policy in 1985?

c. How might this situation affect our national defense at present?

d. How might this situation affect our national defense in the future?

STUDENT ACTIVITY #3

3. FACTS: The following are the sources of U.S. energy in 1977.

Petroleum--48%
Natural Gas--26%
Coal--18%
Nuclear--3%
Hydropower and Geothermal--3%
Oil Shale--1%

We have in this country one of the largest reserves of coal in the world as well as one of the largest supplies of oil shale.

a. How dependent are we as a society on Petroleum? On Natural Gas?

b. What environmental problems might occur if we turn more to coal? To Nuclear Power? Oil Shale? Hydropower and Geothermal?

c. Why, besides national security, is it important that we find alternatives to our use of Petroleum?

4. STATEMENT OF FACT: Gasoline Prices in Some Industrial Countries.

	REGULAR	PREMIUM	DIESEL
France	$1.67	$1.80	$1.09
Germany	$1.41	$1.50	$1.40
Italy	$2.05	$2.13	$0.66
Japan	$1.67	$1.85	$0.88
United Kingdom	$1.10	$1.22	$1.20
United States	$0.62	$0.68	$0.57

Average price in mid 1977, based on per gallon.

a. Why do foreign cars tend to get better mileage than American cars?

b. What might happen if the price of gasoline was raised to the level of some of these other countries?

c. Compare these prices with today's prices.

5. STATEMENT: "The U.S. is by far the largest energy user of any nation on earth. We consume more energy than the Soviet Union, Japan, Great Britain, and West Germany combined. Our consumption is six times as much per man, woman, and child as the world average."

a. How might this fact be viewed by someone from a Lesser Developed Country such as India? A developed country like Germany?

b. What might we do as Americans to make the distribution of energy more equal without lowering our standard of living too much? What could you do personally?

STUDENT ACTIVITY #3

6. Answer the following questions based on the graph on the following page.

a. What seems to be the major problem in our energy requirements in the year 2000?

b. How much will our dependence on oil decrease by 1985? By the year 2000?

c. What new sources of energy will fill the U.S. requirement in the year 2000?

d. How important will Natural Gas be by the year 2000?

e. Since the United States will be no less dependent on foreign petroleum and natural gas by the year 2000, what must we really do to decrease our dependency?

PAGE XIV-27 "OIL: GLOBAL WEAPON" WORKSHEET 320760
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LESSON PLAN: Day 12--The Politics and Economics of Oil Today
--The Energy Crisis - The Feeling of Scarcity

Some feeling of scarcity or the idea of what we should do. without energy is needed. The video tape presents this problem by examing how various communities simply do without. The problem is that the video tape is 60 minutes, so its important that the teacher view the tape and decide how much and what parts to show.

TEACHER PREPARATION:

1. Video Tape machine and TV
2. Video tape: Energy: Nebraska Educational Television Network, Lincooln, 1976.

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LESSON PLAN: Day 13-15--The Future: Alternative Energy in an Age of Scarcity.

We have reached a point in the Unit in which one might ask "What can we do?" The student should now have an opportunity to examine some of the alternatives being developed in energy while at the same time developing some idea of the attitude problem in regards to energy use. First of all the student should be allowed to develop through research a basic understanding of the various alternatives available in the area of energy. Likewise some concepts of energy conservation should also be established in relationship to these alternatives. Each student should complete Student Activity #4 outside of class.

The problem of attitude is more serious in that its one of the primary, yet somewhat intangible, aspects of the energy crisis and the problem of scarcity. The series of filmstrips with discussion after the filmstrips can deal with the problem of attitude.

The first filmstrip,"The Age of Scarcity", #3, deals with the attitude in all areas of scarcity. This filmstrip points out the relationship of scarcity and conflict in history as well as the ideas of self-sacrifice and cooperation which have occurred. Also problems of hardship, unemployment, famine, and other human related problems, are dealt with as they relate to increasing scarcity--especially in the area of scarcity of petroleum and other energy resources. Probably the most important concept discussed is an economic alternative to scarcity, "no growth" economics. The pros and cons of "no growth" is discussed in the filmstrip and can be a good basis for class discussion.

The second set of Filmstrips (The Energy Crisis, 3 parts) deals with both the problem of attitude and possible alternatives. The first filmstrip, "Why Do We Have an Energy Crisis?" deals with the situation of having a fuel shortage while at the same time we seem to have an abundance of fuel resources. What is examined is the role of government, policy, corporate management, and personal consumption as it related to energy. Conservation as an alternative is then examined in the relationship to all three factors, but with emphasis on personal consumption.

The second filmstrip, "The Expanding Crisis", examines two factors--the economic results of the expanding energy crisis and the role of coal as an interim fuel until other resources and alternatives can be developed. Discussion can range from the economic questions of petroleum waste, environmental problems, and coal related issues in mining, pollution, and so forth.

The third filmstrip, "Futuristic Solutions", deals with alternatives such as geothermal, solar, wind, and nuclear fission, and fusion. Problems in developing each of these methods is discussed. The information here can be utilized in Student Activity #4 and for class discussion.

TEACHER PREPARATION:

1. Filmstrip: The Age of Scarcity, Filmstrip #3, Westinghouse Learning Press, New York, 1974. (Part 3 of a set of 3.)
   The Energy Crisis, Filmstrip #1, 2, and 3, Westinghouse Learning Press, New York, 1973.

2. Filmstrip Projector and cassette recorder.

3. Prepare Student Activity #4.

MAJOR TEACHING STRATEGIES:

1. Hand out Student Activity #4. This can be done in class discussion or as an assignment to be handed in as homework.

2. Preview filmstrip and read the teacher's manual.

3. From the teacher's manual, or on your own, select questions to ask before the filmstrips are shown.

4. Using the questions in the teacher's manual, your own question, or the student's, discuss the filmstrip.

5. Space the filmstrips over the three days to insure discussion of that material along with the material in Student Activity #4.

STUDENT ACTIVITY #4 NAME: ____________________________

Solving the energy problem is not simply a job for government or corporate business. It is in fact our job. It is our job to make sure government does its job. It is our job to make sure that business does its job. But even more important is that we do our job by being personally activie and aware of the issues and alternatives in regards to energy.

In this exercise it is your task to research the following energy alternatives to the point of being able to discuss them intelligently with your parents or in a letter to your Congressman or maybe even the President of the United States.

Answer each question completely and with as much detail as possible.

1. Personal conservation of energy resources is an important aspect of finding solutions to the energy problem. Why would your personal actions affect solving the energy issue?

2. Certain conservation measures might well determine how fast we run out of petroleum. Describe how the following measures might make a difference in this fact.

   a. The 55 MPH speed limit.

   b. Right (or left) turn on red.

   c. Turning thermostats to 68°F.

   d. Home insulation to proper depth and R factor.

   e. Turning lights off in rooms not in use.

   f. Using lower wattage in light bulbs.

   g. Recycling aluminum and paper.

3. Below is a list of various energy alternatives which are available to us (at least in theory if not in fact), which may solve at least some of our energy needs in the future. Briefly describe or define each energy alternative, its possible application to our energy needs, and the advantages and disadvantages of each alternative.

   a. Coal

   b. Geothermal

   c. Active Solar Energy (The Solar Farm)

   d. Active Solar Use in the Home

   e. Passive Solar Energy

STUDENT ACTIVITY #4

f. Satellite beaming solar energy to earth

g. Wind energy

h. Tidal energy

i. Nuclear fission

j. Nuclear fusion

k. Oil Shale

4. If you were an official of the Department of Energy what energy alternatives would you recommend to the President and Congress as a short term solution to our petroleum and energy shortage? What would you recommend as a long term solution? Keep in mind that research in any one area may cost billions of tax dollars to develop.

5. Suppose you were an executive of a major energy producing corporation. What actions would you recommend to your company as they relate to energy alternatives?

EVALUATION SUGGESTION:

Student evaluation for this unit can be accomplished in four ways. It is left to the individual teacher how this evaluation should be carried out or even if all four will be used. The reason for this is that it's the teacher in the classroom who must deal with the student thus any canned test or other standardized forms of evaluation has been left out of the unit. Only the teacher in the classroom can really judge his or her own class, thus it should be up to the teacher to determine the methods of evaluation.

The following suggestions are recommended:

1. Since classroom discussion, research, and the use and application of facts are a part of the objectives of this unit, they therefore become a part of the method of evaluation. The problem is that classroom participation may become more than a matter of judgement. For this reason the teacher should research the facts before he or she presents the unit.

Probably the best way to evaluate the student is to observe that student's use of the information in intelligent discussion. The student has a right to an opinion, but he or she has to back up that opinion with legitimate facts. This may not be simple, but it is a basis for further evaluation. From this point the teacher can fall back on his or her own method of evaluation of classroom participation. Caution, of course, must be taken to avoid being snowed by the student who talks but says little. For students who do not participate it is necessary to draw out the information through questions.

2. Daily or assigned work is the second method of evaluation. How much emphasis on this depends on the teachers own time to read and check the Students Activities and the Group Report. The Group Report and related work will take little time to evaluate but, it may be necessary to check individual work to make sure that all students contributed to the report instead of a few doing the work while the rest benefit.

Evaluating the Student Activities might give the teacher an opportunity to evaluate students who may not openly participate in class for whatever reason. Careful attention should be paid to the information given, but also to the quality of how it is given. In short the evaluation of writing skills is as important as an evaluation of the facts presented.

3. Quizzes might be used to check the students progress during the unit although none are scheduled in the material. It is a means to check the direction the unit is taking as much as checking the facts.

4. A unit test is one of the most important means of evaluation since it is a way of checking the success or failure of the entire unit. An objective test gives the student a chance to exercise knowledge of the facts and in some cases how to analyze the facts. An essay test allows the student to use and apply the facts by blending information found and formulated throughout the unit. This might be the better form of evaluation, if time permits, for the process of evaluating answers.

Blending both objective and essay questions may be better since it gives the student an opportunity to display both knowledge of the facts as well as an understanding of the same facts.

As stated earlier, no example of a test is provided because it is necessary for the teacher to apply the unit to the students involved in the unit. It may be that each class involved in the unit may need to be evaluated in a different way or the teacher may feel that part of the unit is not necessary and omit that part making any standardized test invalid or impractical.

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SOLAR USE
IN
FOOD
PREPARATION
and
PRESERVATION

An interdisciplinary approach for Social Studies, Science and Home Economic Teachers.

by

Jerry L. Freiberg

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ABSTRACT

The purpose of this exercise will be to introduce the student to alternate means of food preparation and preservation through the use of solar energy. This will be carried out through the use of the sun by introducing the history of the American Indians in their food preservation and how modern man, through the use of a solar cooker or solar dryer, can accomplish the same means.

RECOMMENDED LEVEL

This exercise is actually an interdisciplinary unit, designed for easy application to the junior high or senior high departments of social studies, home economics and science. Labs are presented with alternate means of completion in different degrees of difficulty.

TIME REQUIRED

This unit can be easily covered in one week to ten days, depending upon the amount of solar energy available (cloudy days will have to be accounted for) or upon the teachers approach to the subject matter.

PROJECTS AND ACTIVITIES

The class should be prepared for this exercise with one or two days of introduction, explaining the priciples of solar energy and showing pictures of applied solar science. The history of the use of solar energy by the American Indians to dry hides and foods and in the structure of their homes should be introduced at this time. Further help can be gained by having the students look for newspaper articles on solar energy, or other media that are available to them. The teacher can use slides, magizine articles on solar hot water heaters, solar heating units for houses and the parabolic mirror. Following the introduction, the students could be expected to build a solar dryer and the solar cooker. At the completion of the drying process, the fruit may be used as the dessert for the meal prepared in the solar cooker.

ESSENTIAL ADVANCE PREPARATION

To prepare for the lab portion of the exercise, the following equipment will be necessary. Cheesecloth, cardboard boxes, heavy clear plastic, large stones or empty pop cans, black electrical tape (plastic), black paint (spray type), knife, scissors and masking or scotch tape. For an advance section, wood may be used for the building of the solar cooker. The teacher will need some photos of solar units to help in the initial discussion and pictures of the American Indians will help in introducing the historical part of the exercise.

For the second lab, materials will include aluminum foil, protractor, compass, glue, fruit and blender.

GOALS

Through the use of this exercise, the students should understand the principles of solar cooking and possible survivial that would aide them in the need of an alternate source of heat. The students have an understanding of the history of solar energy through its use by the American Indians prior to the use of fossil fuels.

OBJECTIVES

At the completion of the exercise, the student should be able to:

1. Build a solar dryer and prepare fruit for preservation.
2. Build a solar cooker and prepare hotdogs or roast with it.
3. Explain how the Indian used the sun to dry their food.
4. Explain how solar energy can be used to heat water or homes and the need for an alternate energy source.

CLASSROOM ACTIVITIES

This unit will take from five to ten lessons, depending upon the age groups, their background and the available solar energy. The following lesson plans are to serve as an aide to the teacher. Some items may be copied for the students work. The labs are in a seperate section and are designed for alternate degrees of difficulty.

Activity I.

Explain to the students, with the aide of the supplied pictures, how the American Indians used solar energy as a means of food preservation for the winter months. This can include the collection of berries by the Indians and the kinds of foods preserved by them.

The teacher would then explain how these same techniques can be used by present day man as a means of food preparation and how dried foods are used by hikers and in emergency situations. At this time, the teacher may also bring in some foods that the students are familiar with such as raisins or dates, explaining how these foods have been used for years by travelers in the Near Eastern countries.

Through the use of pictures and slides, other applications of solar energy can be introduced; i.e. solar water heaters and solar collectors on houses as an alternate heat source in our homes.

Following this introduction to the subject matter, the class would hold a discussion with the possible listing of homes in the area that have solar units. The students should have a chance to bring out other items that they are familiar with, such as the dried pears, apricots or other food items. Examples of questions that may be asked are:

1. Why should we be looking for an alternate heat source?
2. How can we apply the sun's energy to the way we dress?
3. In our use of fossil fuels we say that we are using the stored energy of the sun, explain what is meant by this.

Activity 2.

The teacher should explain the movement of the sun and how the different seasons are caused by the rotation of the earth and the placement of the sun. The teacher should then explain how solar energy is effective through the adjustments to the amount of the sun's rays. For the advanced classes of science, the use of the labs on the daily motion of the sun and the Sun-path Chart may be used to stress this point. For lower classes, the lab on Suntracking would be used as a means of showing the students the movement of the sun.

Following these labs, the teacher can introduce the principle of the parabolic mirror (used in the solar cooker) and how black objects tend to absorb heat and allow for more effective use of the suns energy.

Activity 3.

The teacher should explain how the solar dryer is to be made and allow the students to construct their own solar dryer by using a cardboard box or wood. The cheesecloth, plastic, black paint and large rocks will be used in this lab. The directions are included in the laboratory section of the unit.

Activity 4.

Now that the solar dryer has been completed, the students would be expected to wash the fruit and prepare them according to the recipes included. If fruit leather is to be made, the students must prepare the fruit prior to placing into the blender by removal of the seeds and stems. At this point, the students may want to experience the method used by the Indians and use a bowl and round stone to crush the fruit rather then use a blender.

Following the preparation of the fruit (jerky may also be made, the recipe is in the illustration section), place the food on the dryer and place in the sun following the principles learned in Activity 2.

Complete the day by having a discussion related to the need for washing the food. If the Indian method of making leather was used, ask the students for their feeling about this method of food preparation.

Activity 5.

Explain to the students how the solar cooker is to be made (you have two choices in the lab section). Be certain that all inside surfaces are covered with aluminum foil. Carefully glue to curved surface to the round edges of the mirror portion of the cooker. Allow the mirror to dry before attaching to the base of the cooker. It may be necessary to use tape to help hold the surfaces in place while drying.

Activity 6.

Once the assembly of the solar cooker is completed, show the students how to adjust the sun's rays onto the parabolic surface so the rays will be focused upon the cooking area. (There is a transparency available to aide you in this.) Let the students experiment until they are able to feel the heat being generated through the focal point of the mirrored surface. They may want to test the amount of heat with the use of a thermometer to see just how hot the surface is.

Activity 7.

If desired, the lab on collection of clean water may be used at this point. This will allow the students a means of seeing how water can be collected as a means of survival. Explain the process of evaporation and condensation and how the sun's energy is used in this process through the heating of the water and the cooling of the water on the plastic top.

Activity 8.

Weather permitting, allow the students to prepare a meal with the use of their experimental equipment. The students can prepare hotdogs in the solar cooker and then follow the meal with the dried fruit from Activity 4.

Activity 9.

Discuss the sun's ability to cook the meat in the solar cooker or to dry the fruit in the solar dryer. Be certain to point out the convection currents that would have been present in the dryer and the use of the large stones or bricks as storage areas for the solar heat.

Activity 10.

To complete the section, some type of evaluation is recommended. This can be accomplished through an oral discussion, the use of an objective test or through the use of an essay exam. Examples of possible questions are listed below.

Essay Exam

1. Explain how solar energy can be used as an alternate energy source, listing at least three examples that you have studied.

2. How can solar energy be used by someone lost in the desert or other barren place?

3. Many people feel that solar application is new to man. Through this course you have learned that solar energy had been used by primitive man. In what ways has the sun helped man to survive?

4. Why is it necessary to take into account the areas where you live and the seasons of the year when you are using solar energy?

Objective Questions:

True or False

____ 1. The sun has a constant path at all times of the year.

____ 2. Man has been using the sun as an energy source for many years.

____ 3. Since solar energy is a new source of energy, man really doesn't know how to use it.

____ 4. The sun's energy can be stored in a thermal mass and in this way keep a house warm even after the sun has gone down at night.

Matching

____ 1. Angle between the sun and the horizon.

____ 2. The angle of the sun between a line horizontal and a line south.

____ 3. Curved surface used in the mirror for cooking.

____ 4. Best color used for absorbing heat.

____ 5. Best color for reflecting solar heat.

a. White
b. Silver
c. Black
d. Altitude
e. Latitutde
f. Azimuth
g. Zenith
h. Parabolic

550

TEACHERS AIDES

LECTURES

LABS

SUNTRACKING - OBSERVING THE SUNPATH

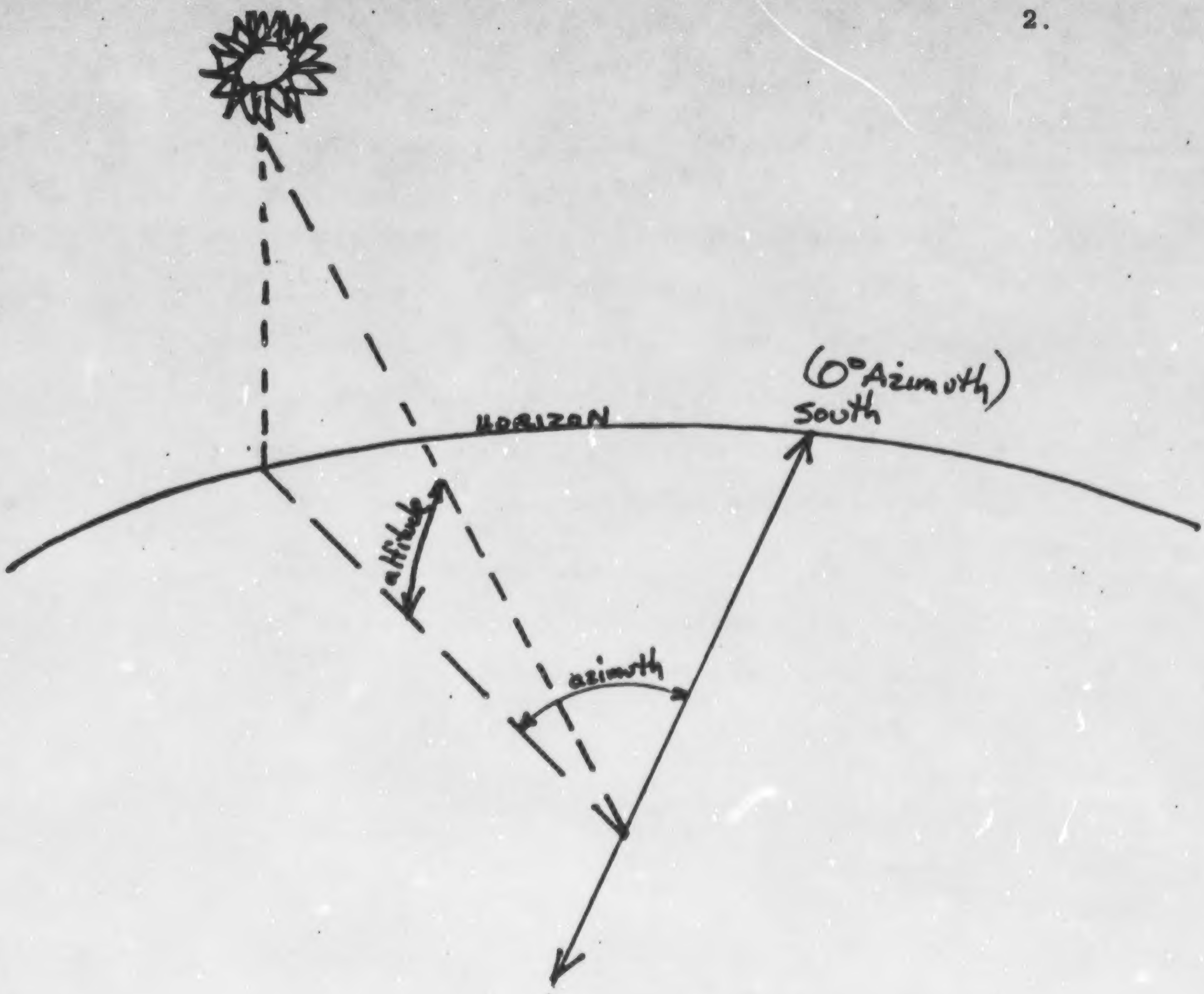
The sun's position in the sky at any given time has a major effect on how much solar energy will be received at the earth's surface. In order to collect and use solar energy in a skillful manner, it is necessary to study the apparent movement of the sun through the sky, including both daily and seasonal patterns.

As we learn to accurately predict where the sun will be at any given time, we can learn to orient our solar collectors properly. This information also assists in the design of overhangs on buildings to prevent overheating in the summer, and is useful for the understanding of the effects of vegetation and window placement on buildings.

When observing the sun's position in the sky the terms altitude and azimuth are used.

The sun's altitude is the angle between the sun and the horizon; the horizon here being a perfectly level one, not obscured by mountains, trees or buildings.

The sun's azimuth is the angle between the line, projected horizontally, from the observer to the sun, and the line pointing due South. Due South is 180 degrees from true north, which should be adjusted from magnetic north.


(0° Azimuth)
South
HORIZON
altitude
azimuth

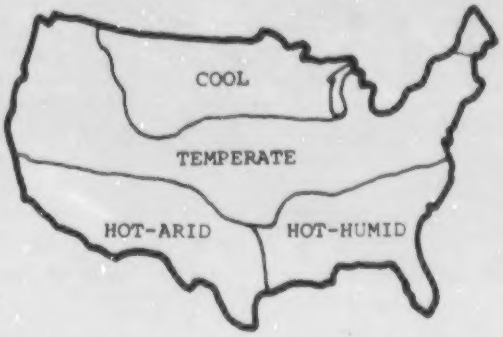
Both altitude and azimuth are measured in degrees. At solar noon, the sun's azimuth is 0 degrees. Azimuth before noon can be referred to in "degrees east of south," and azimuth readings after solar noon can be called "degrees west of south."

Basics of Solar Utilization

A. Climate

Sun, wind, temperature, humidity and many other factors shape the climate of the United States. Basic to using solar energy for heating and domestic hot water is understanding the relationship of sun, climate and dwelling design.

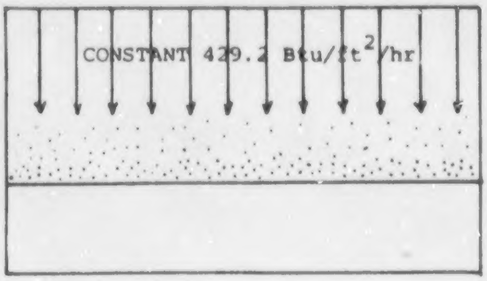
The amount and type of solar radiation varies between and within climatic regions: from hot-dry climates where clear skies enable a large percentage of direct radiation to reach the ground, to temperate and humid climates where up to 40 percent of the total radiation received may be diffuse sky radiation, reflected from clouds and atmospheric dust, to cool climates where snow reflection from the low winter sun may result in a greater amount of incident radiation than in warmer but cloudier climates.



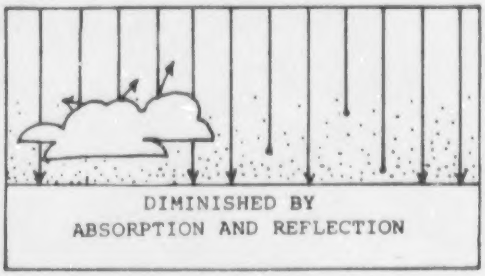
As a result of these differences in the amount and type of radiation reaching a building site, as well as in climate, season and application — heating or domestic hot water — the need for and the design of solar system components will vary in each locale.

B. Solar Radiation

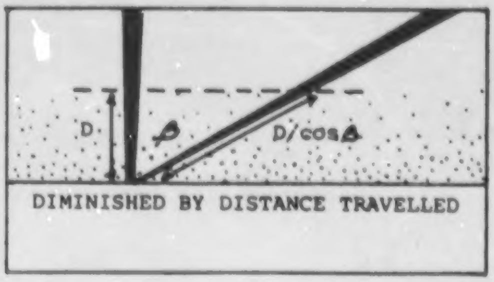
The sun provides almost all of the earth's energy in the form of radiation. Solar energy, also known as solar radiation reaches the earth's surface in two ways" by direct (parallel) rays; and by diffuse (nonparallel) sky radiation. The solar radiation reaching a building includes not only direct and diffuse but also radiation reflected from adjacent ground and building surfaces. It is these three sources of solar radiation that may be used for space and domestic hot water heating.



1. THE SOLAR CONSTANT A nearly constant amount of solar energy strikes the outer atmosphere = 429.2 BTU per square foot per hour. This quantity is known as the solar constant. A large amount of this energy, however, is lost in the earth's atmosphere, and cannot be regained regardless of collector design.

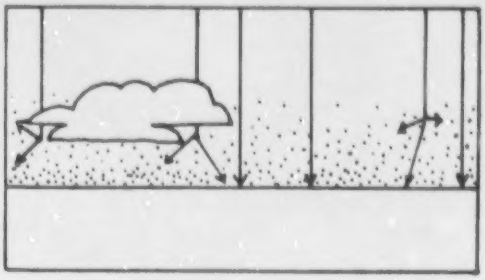


2. ABSORPTION AND REFLECTION On the average, almost half of the solar radiation reaching the earth's outer atmosphere is lost by absorption in the atmosphere and by reflection from clouds, as it passes through the atmosphere to the earth's surface. The radiation lost actually varies between 60% in Seattle, Washington and only 30% in Albuquerque, New Mexico.

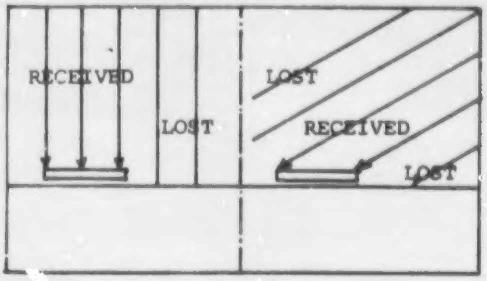


DIMINISHED BY DISTANCE TRAVELLED

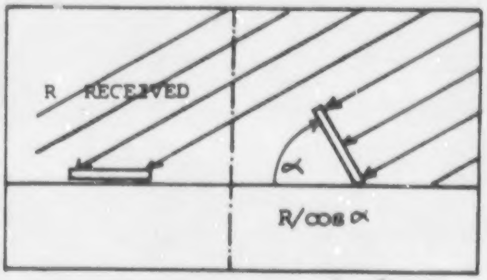
3. EARTH'S ATMOSPHERE As already stated, the radiation reaching the earth's surface is diminished by the condition of the earth's atmosphere: its purity, vapor, dust and smoke content. At lower sun angles, the length of travel through the atmosphere is greatly increased, so the relative amount of radiation received is further diminished.



4. DIFFUSE RADIATION Clouds and particles in the atmosphere not only reflect and absorb solar energy, but scatter it in all directions. As a result, a part of that solar radiation reaching the earth's surface is diffused, and received from all parts of the sky. Diffuse radiation, as opposed to direct radiation, is of a greater percentage on hazy days than clear ones. At most, however, diffuse radiation can only be about one quarter of the solar constant, or about 100 BTU/hr./sq. ft.

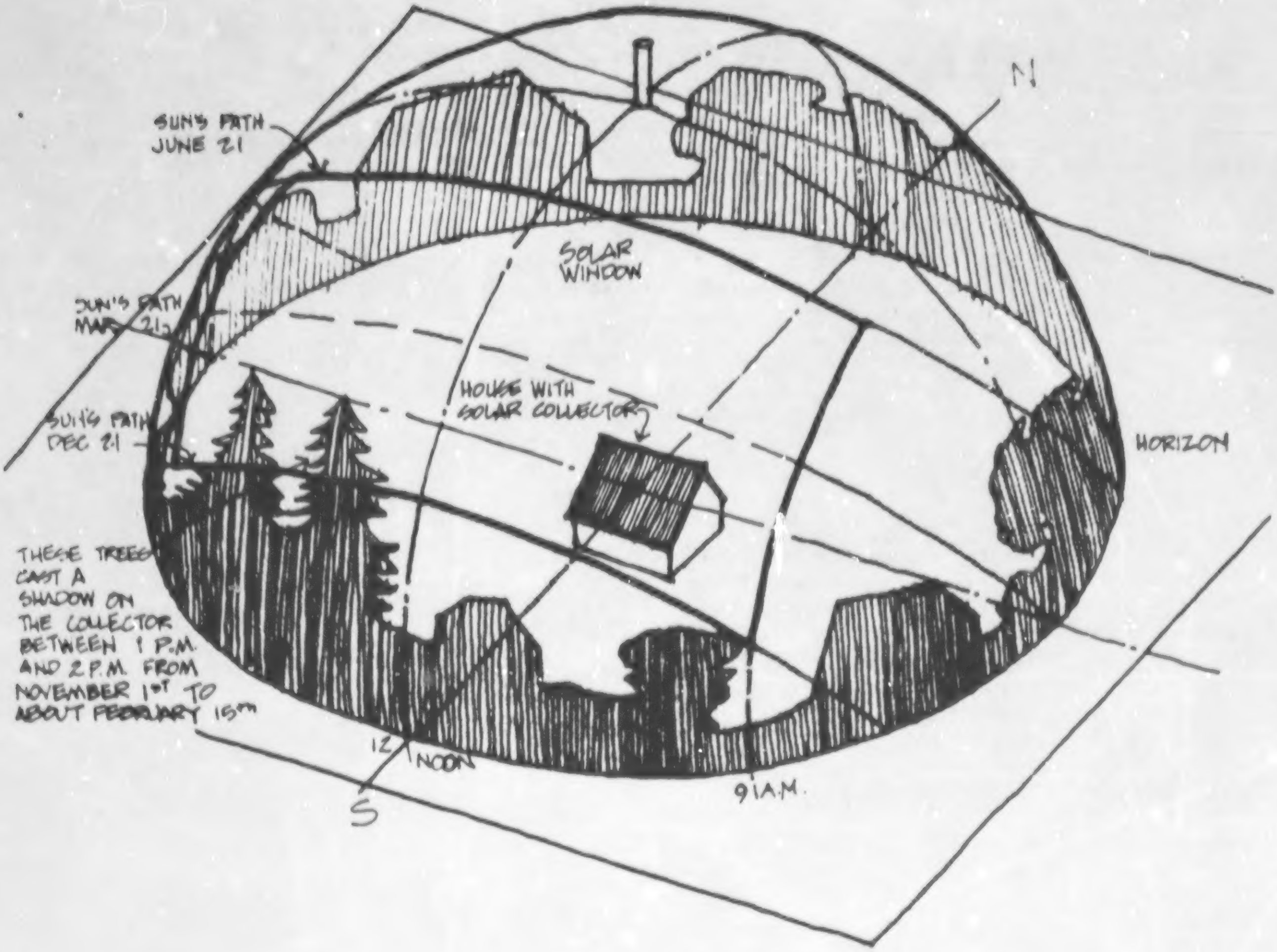


5. DIRECT RADIATION ON A HORIZONTAL SURFACE Although the amount of radiation remains constant, less radiation strikes a given horizontal area as the sun gets lower in the sky.

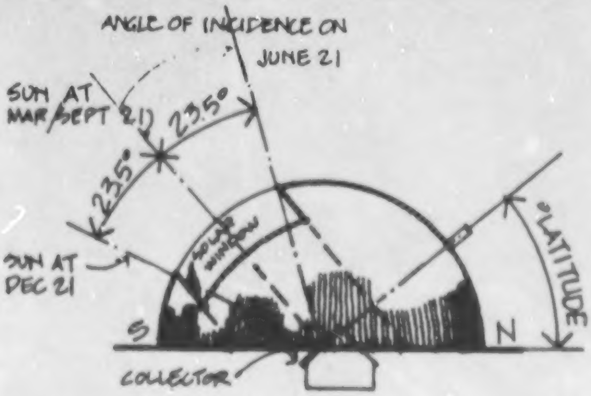


6. DIRECT SOLAR RADIATION ON A TILTED SURFACE The same principle applies to a tilted surface such as a collector. By tilting the collector so that it is nearly perpendicular to the sun's ray, more energy strikes its surface, undiminished by the cosine factor.

C. Solar Window

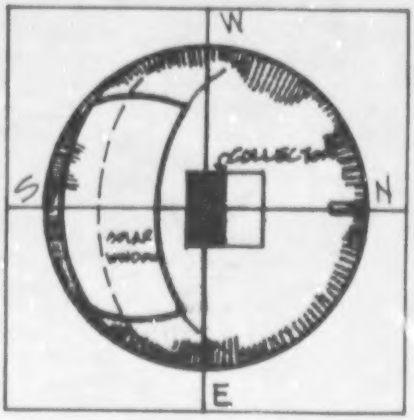

SUN'S PATH JUNE 21
SOLAR WINDOW
N
SUN'S PATH MAR 21
SUN'S PATH DEC 21
HOUSE WITH SOLAR COLLECTOR
HORIZON
THESE TREES CAST A SHADOW ON THE COLLECTOR BETWEEN 1 P.M. AND 2 P.M. FROM NOVEMBER 1ST TO ABOUT FEBRUARY 15TH
12 NOON
9 A.M.
S

THE SOLAR WINDOW Imagine the sky as a transparent dome with its center as the solar collector of a house. The path of the sun can be the outline of surrounding houses and trees. The morning and afternoon limits of useful solar collection (roughly 9 A.M. and 3 P.M.) and the sun's path between those hours throughout the year scribes a "solar window" on the dome. Almost all of the useful sun that reaches the collector must come through this window except for the added effect of diffuse radiation. If any of the surrounding houses, trees, etc., intrude into this "solar window," the intrusion will cast a shadow on the collector. The isometric drawing above illustrates the "solar window" for a latitude 40° N. The solar window will change for different latitudes.

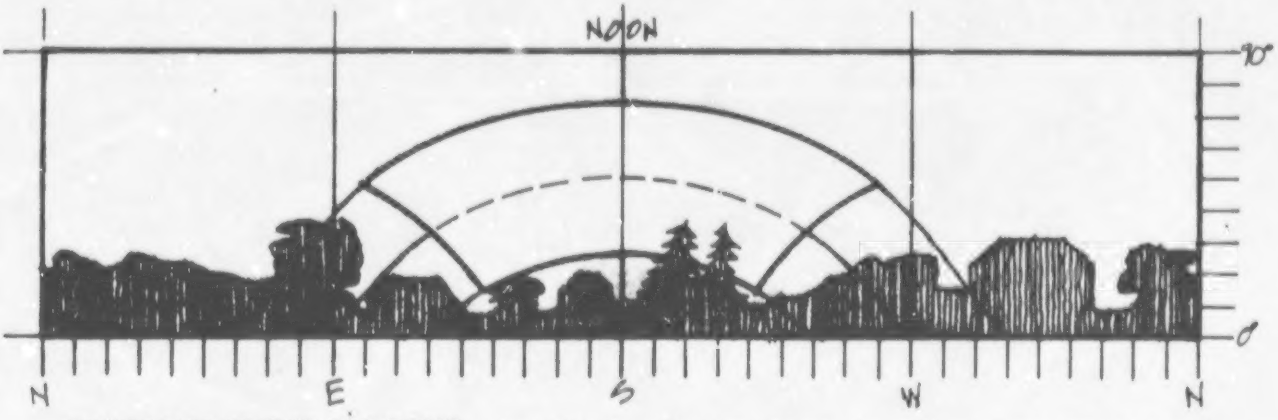


SIDE VIEW OF SKY DONE WITH "SOLAR WINDOW" A side view of the sky dome from the east illustrates the relative position and angle of the sun throughout the year that defines the boundaries of the "solar window."

note: This would be a good point to introduce the term angle of incidence often used in solar collector design. The angle of incidence is the angle measured from the normal of the collector surface to the line indicating the sun's altitude, at a particular time.



PLAN VIEW OF SKY DOME WITH "SOLAR WINDOW" Viewed from above the sky dome, the seasonal path of the sun can be plotted thus defining the boundaries of the "solar window." This is easily accomplished by the use of a standard sun path diagram for the proper latitude. Sun path diagrams are widely reproduced and used for determining the azimuth and altitude of the sun at any time during the year; and can also be used to define the "solar window" and surrounding intrusions.



PANORAMA OF THE SKY DOME As with the spherical earth, the spherical sky dome with its "solar window" can be mapped using a Mercator projection, in which all latitude and longitude lines are straight lines. Such a map is very useful for comparing the site surroundings with the "solar window" outline, since both can be easily plotted on the map. Any elements surrounding the site that intrude into the "solar window" will cast shadows on the collector.

SUN-PATH CHART.

In doing this section of the unit, sun-path charts are included in the lab so that you can find the times best allowed for solar collection.

If a sun-site is available, use this piece of equipment to find the solar azimuth and altitude. If you do not have a sun-site, use a protractor and magnetic compass to complete the experiment. Allow for true north on the compass and by attaching a pencil to the protractor with a rubber band and placing this above the compass, the altitude and azimuth is found. The angle on the protractor will give you this information, when the pencil is lined up against any tall objects, such as trees or buildings, that may block the sun at any time of the year.

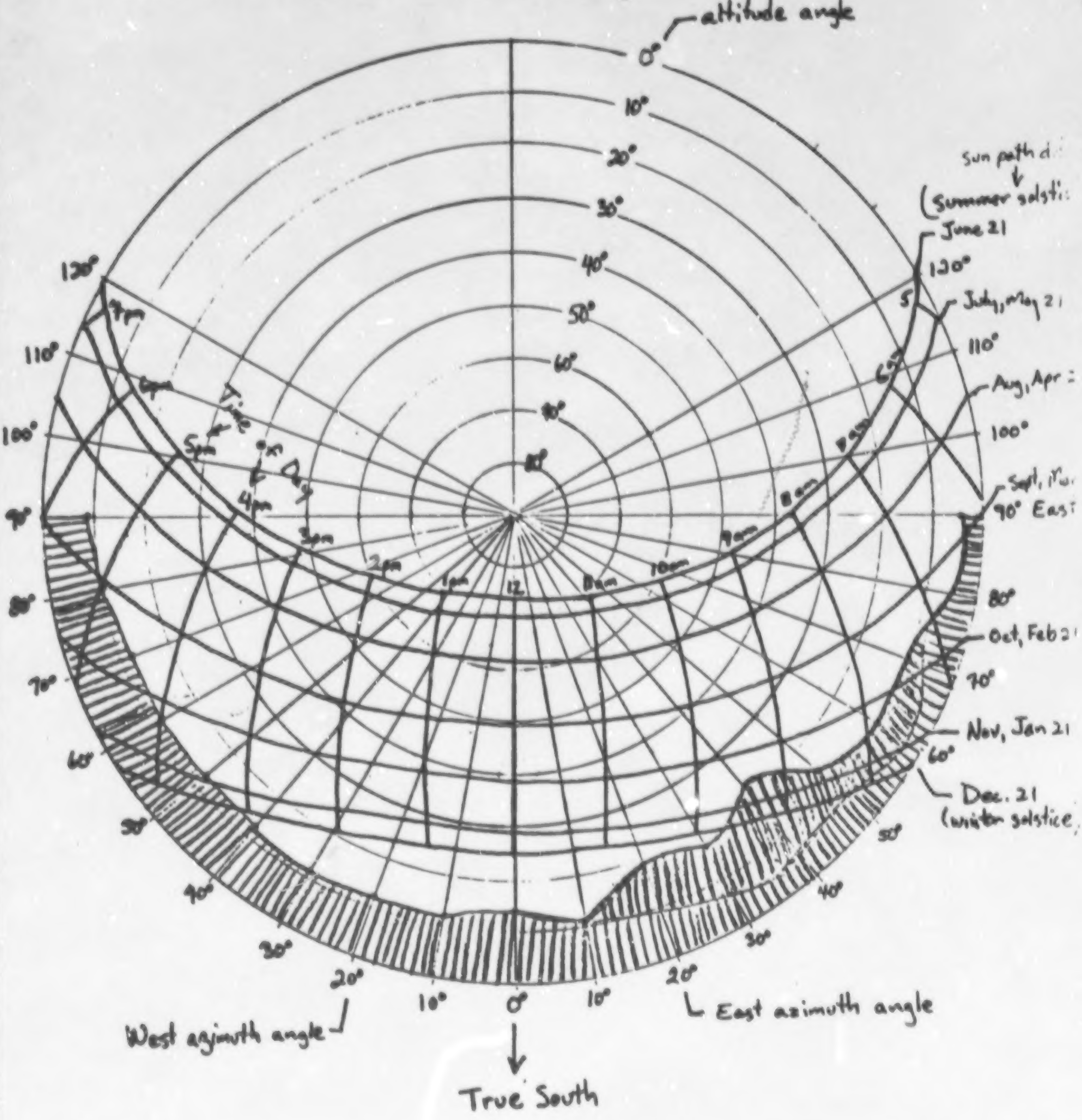
When the data is collected and placed upon the sun-chart, the area for placement of the solar cooker, solar dryer or any other solar equipment will be shown. This will allow for maximum energy absorbtion from the sun.

To aide you, a sample of a completed chart is enclosed to help in filling out the sun-path chart.

If uncertain of the latitude for your area, check any encyclopedia to find the assigned latitude.

SAMPLE SUN-PATH CHART, SITE ANALYSIS EXERCISE

SITE LOCATION Lot 2, No. 3, Br. Crk. Village


altitude angle
0°
10°
20°
30°
40°
50°
60°
70°
80°
120°
110°
100°
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
10°
20°
30°
40°
50°
60°
70°
80°
7pm
6pm
5pm
4pm
3pm
2pm
1pm
12
11am
10am
9am
8am
7am
6am
5
Time of Day
sun path d
(summer solsti
June 21
120°
July, May 21
110°
Aug, Apr
100°
Sept, Ma
90° East
80°
Oct, Feb 2
70°
Nov, Jan 21
60°
Dec. 21
(winter solstice
West azimuth angle
East azimuth angle
True South

SAMPLE: AZIMUTH AND ALTITIDE READINGS

SITE ANALYSIS EXERCISE

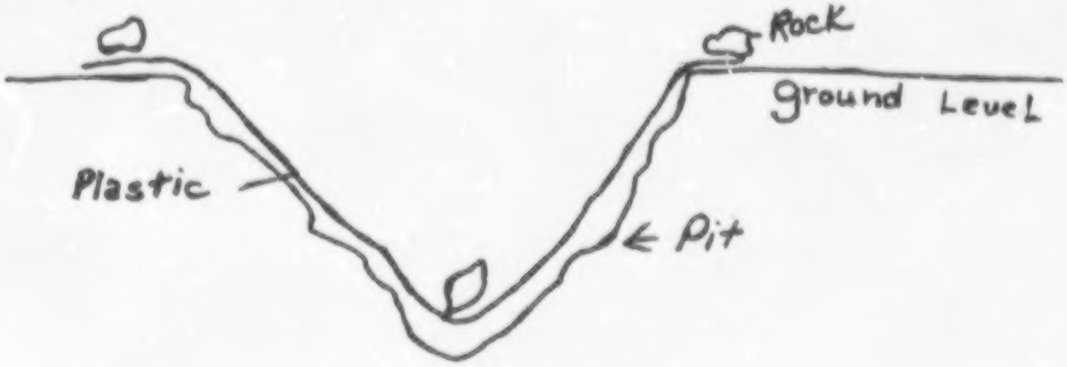
SITE LOCATION Homesite, Lot 2, Block No. 3, Brush Creek Village

Azimuth (West)	Altitude	West	Azimuth (East)	Altitude	East
0°	14°	4°	0°	14°	4°
10°	12°	2°	10°	11°	7°
20°	12°	5°	20°	19°	8°
30°	11°	6°	30°	17°	3°
40°	12°	8°	40°	22°	4°
50°	12°	7°	50°	15°	4°
60°	12°	7°	60°	10°	2°
70°	12°	14°	70°	10°	1°
80°	10°	13°	80°	5°	2°
90°	8°	4°	90°	5°	4°
100°	—		100°	—	
110°	—		110°	—	
120°	—		120°	—	

COLLECTION OF FRESH WATER IN DESERT CONDITIONS

Dig a pit into the ground with sides sloping. Line the pit with solid sheet of plastic and weight corners with stones, placing a stone in the center of the plastic. Allow to stand open over night and collect the water in the morning.

This process will collect from 1/2 to one cup of water over night from natural condensation upon the plastic surface. The primary idea behind this exercise is to stress desert survival.



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ILLUSTRATIONS

Pictures credited to

John A. Anderson Collection
Nebraska State Historical Society

J. L. Freiberg collection

"Solar energy is what keeps you up all night after spending the entire first day of your vacation out in the sun."

"Don't turn your back on solar energy -- if you do, keep a good suntan lotion handy."

JERKING BEEF

PICTURE CREDIT, NEBRASKA STATE HISTORICAL SOCIETY

Jerky

Cut bison, venison or beef into foot-long strips, with the grain so it will be stringy, using any cut of meat available, rump, legs etc. Prepare a very strong salt and water brine and dip the strips in it until the meat is white. Hang the strips in the sun, or place in solar dryer until thoroughly dry. Store the strips in a ventilated container. Jerky may be eaten dry or rehydrated. When used in a stew, jerky is very similar to fresh meat.

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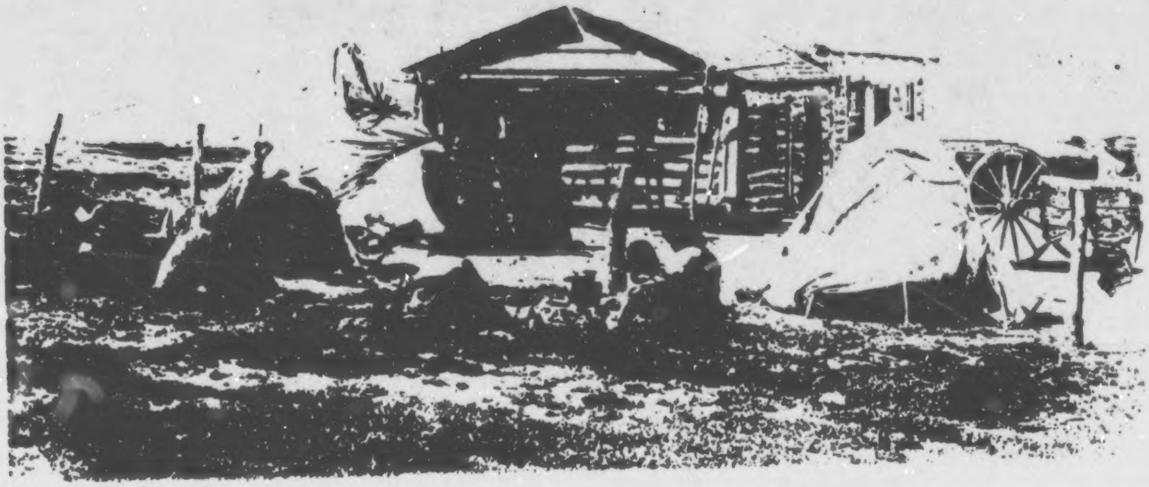
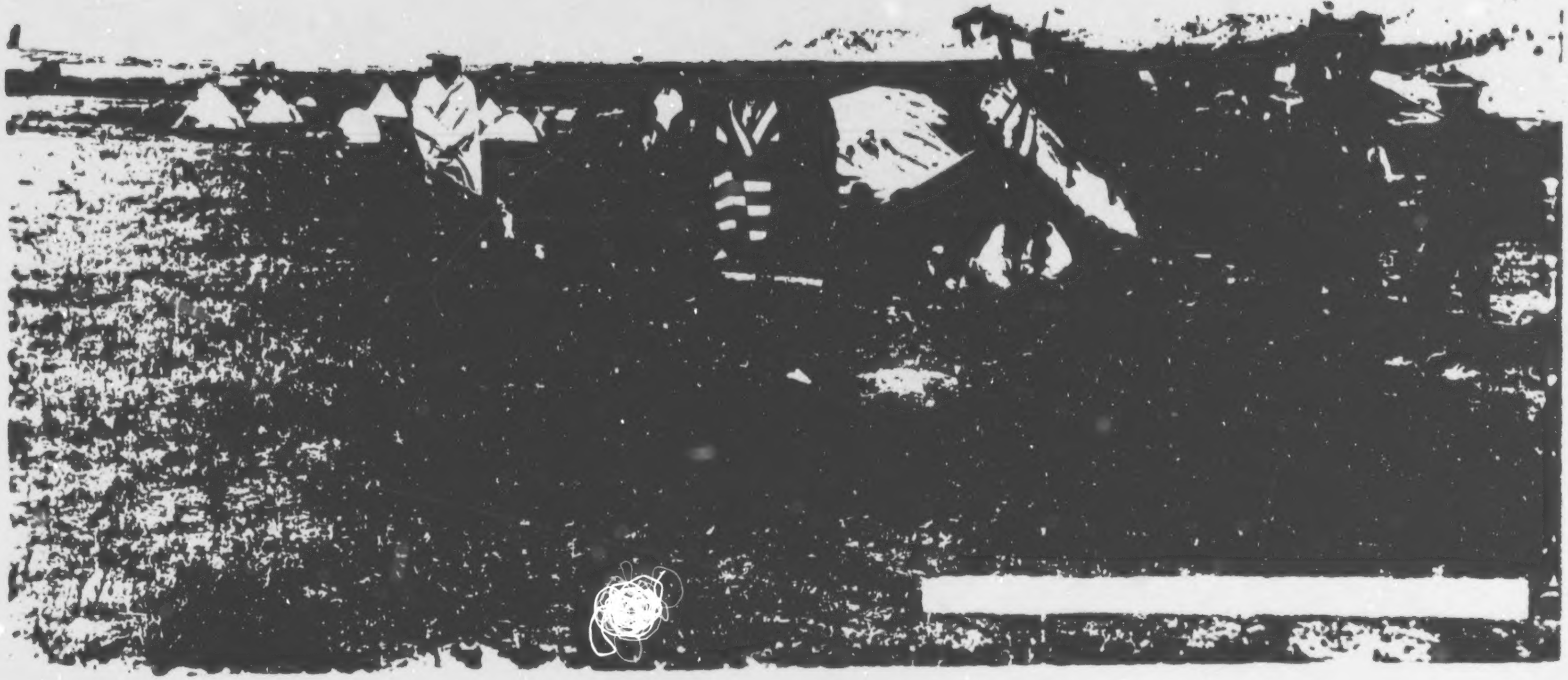


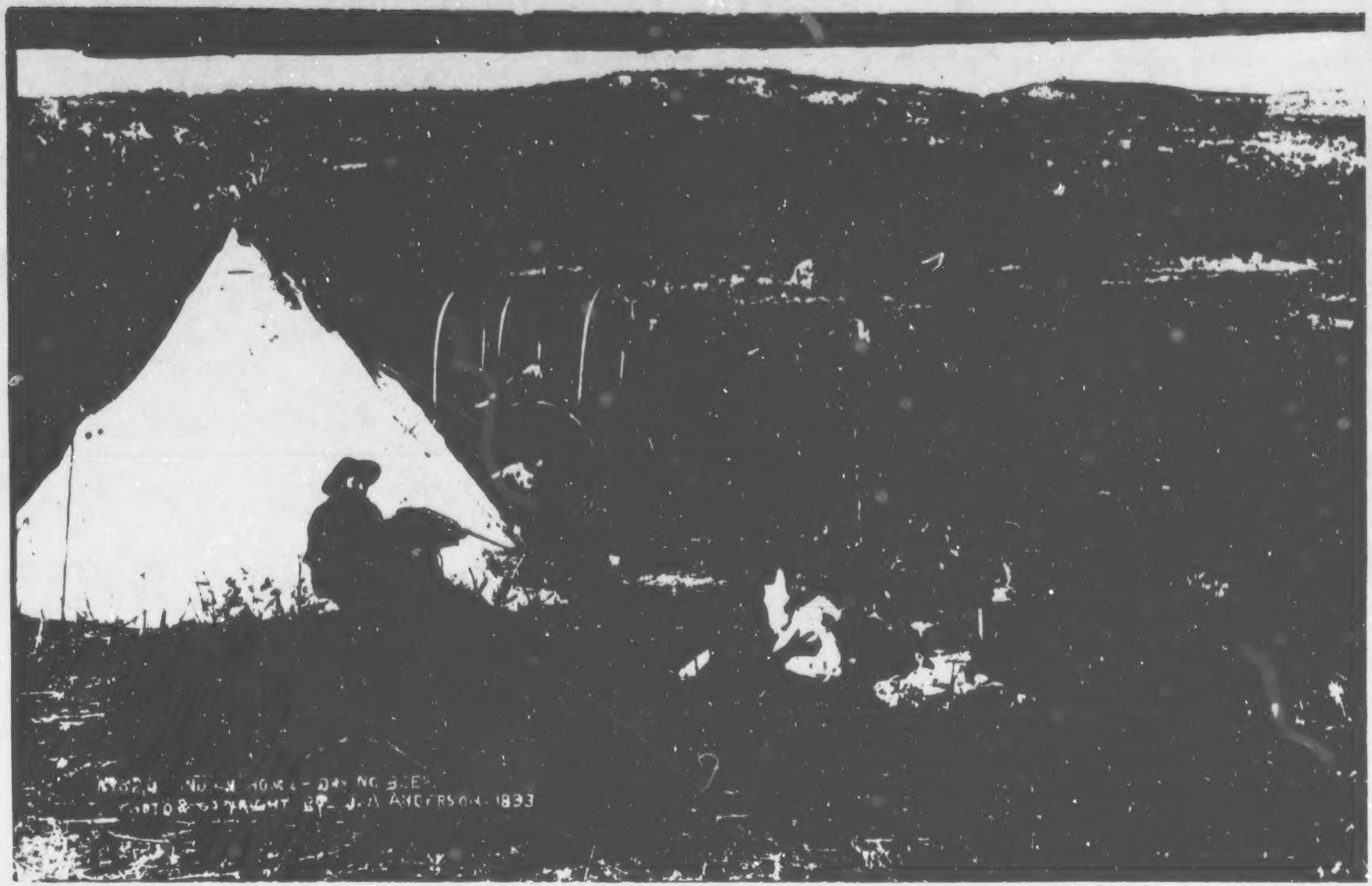
PEMMICAN

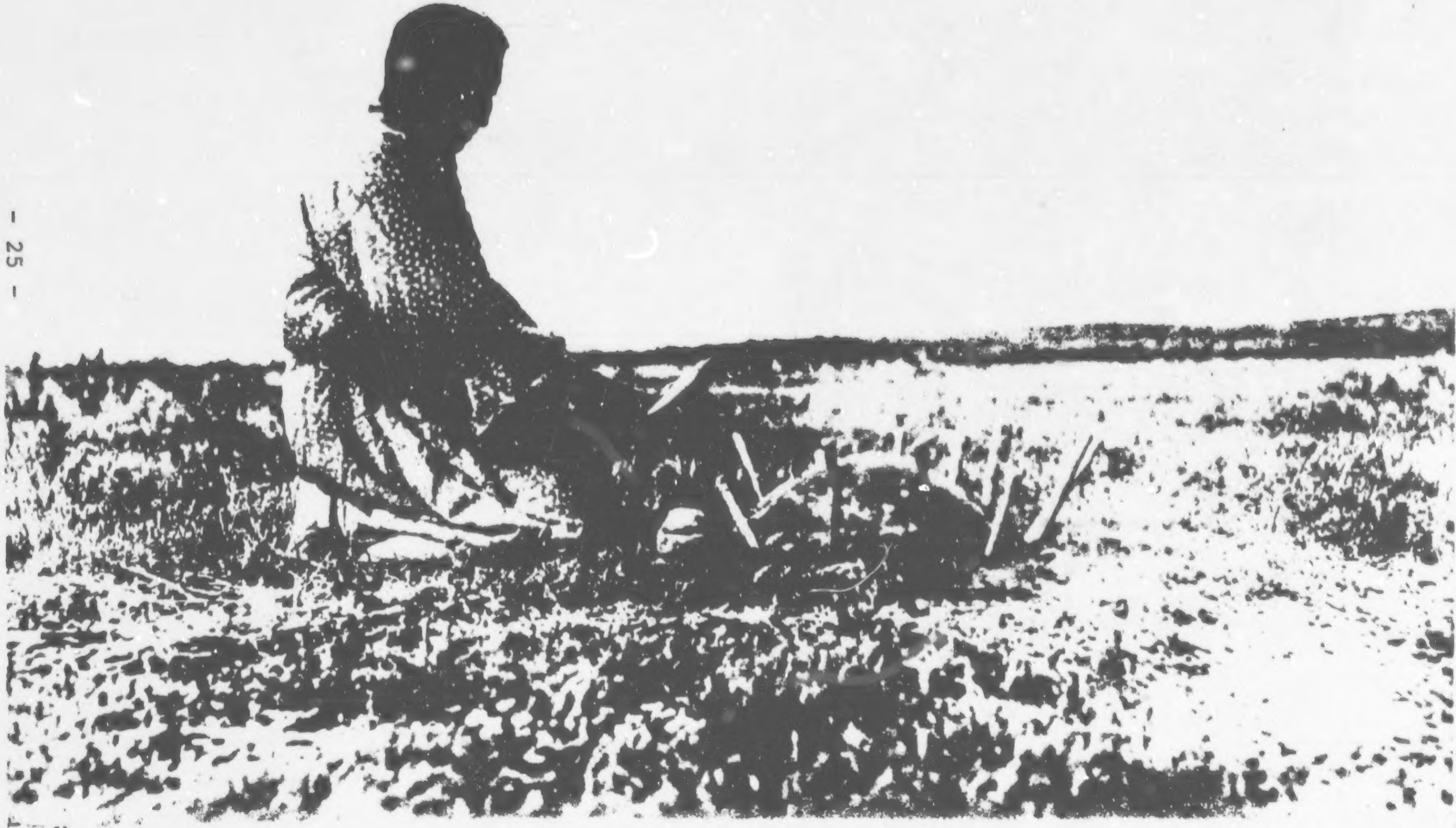
Combine equal parts of buffalo suet; dried fruit such as cherries, berries and plums; and dried venison or other game. Add salt if available and pound the mixture in a bowl or a hollor rock; then form into bricks. Dry in the sun, or near the fire in rainly weather. Pemmican may be simmered in water to make a thick soup or stew.

Cheyenne Indians camped near Red Cloud Agency with jerky drying



Drying beef at an Indian home.


No. 62 INDIAN HOME - DRYING BEEF
PHOTO & COPYRIGHT BY J. A. ANDERSON 1833

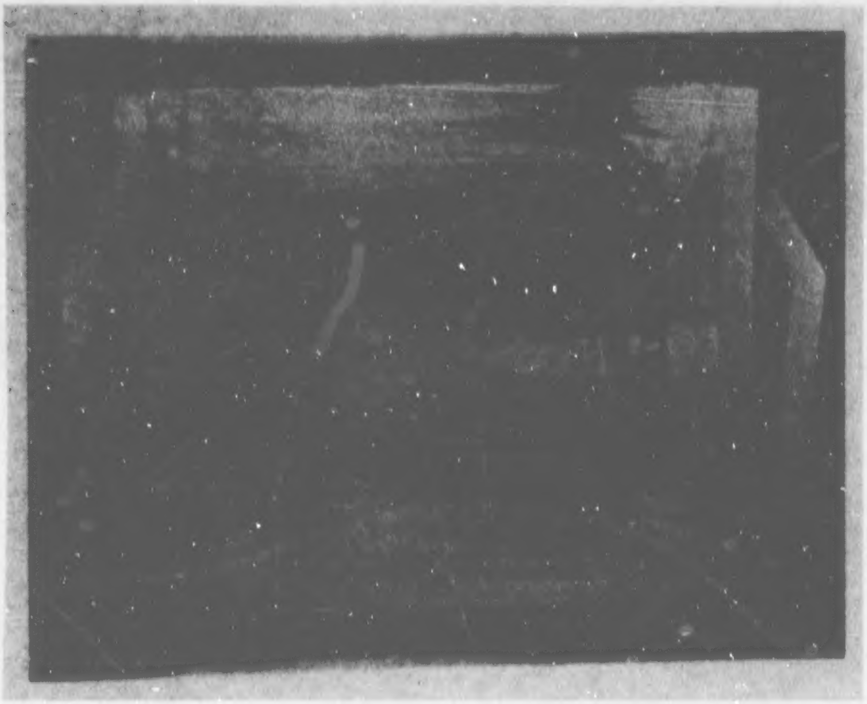


Woman preparing a rawhide bowl for pemmican. After the rawhide has dried in the sun, the berries and suet will be pounded with a rock and then formed into bricks to sun dry.

Solar Model, CRMS, Carbondale, Colorado.

The solar model may be used to show the Greenhouse Effect through the collection of the suns energy passing through the plastic into a closed storage area.
The model is constructed from a cardboard box lined with aluminum foil, which serves as a reflector, and covered with clear plastic wrap. The thermal storage areas are composed of pop cans, painted black and filled with water, and large stones.

This model may be used as a starter bed for seedlings or as a method of demonstrating solar radiation through the heat build up in the container. The importance of storage of thermal energy is demonstrated through heat retention in in cans and rocks.



Solar Hot Dog Cooker, CRMS, Carbondale, Colorado.

The solar cooker is used to demonstrate alternate methods of food preparation. This unit was constructed with wood and lined with aluminum foil to reflect the suns energy to the focal point, nails, in the cooking area.

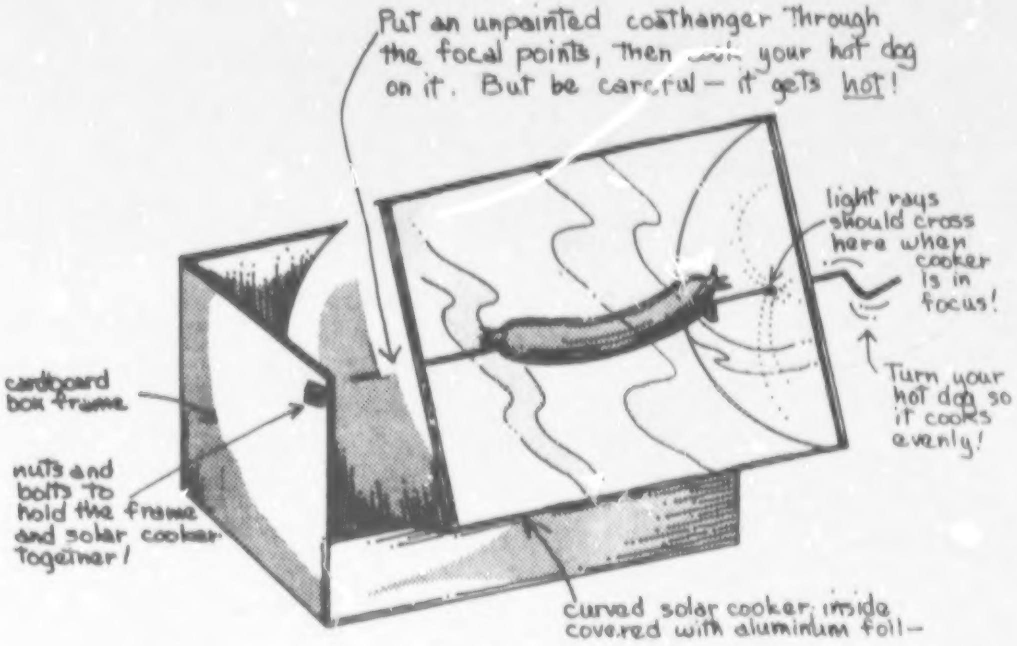
Solar Fruit Dryer, constructed CRMS, Carbondale, Colo.

The fruit dryer is constructed from a cardboard box that has been painted black to absorb the solar energy, covered with plastic to help hold in heat, yet allowing sunlight to enter the box. The drying tray is made of cardboard covered with cheesecloth to allow easy drying through the normal flow of convection currents.

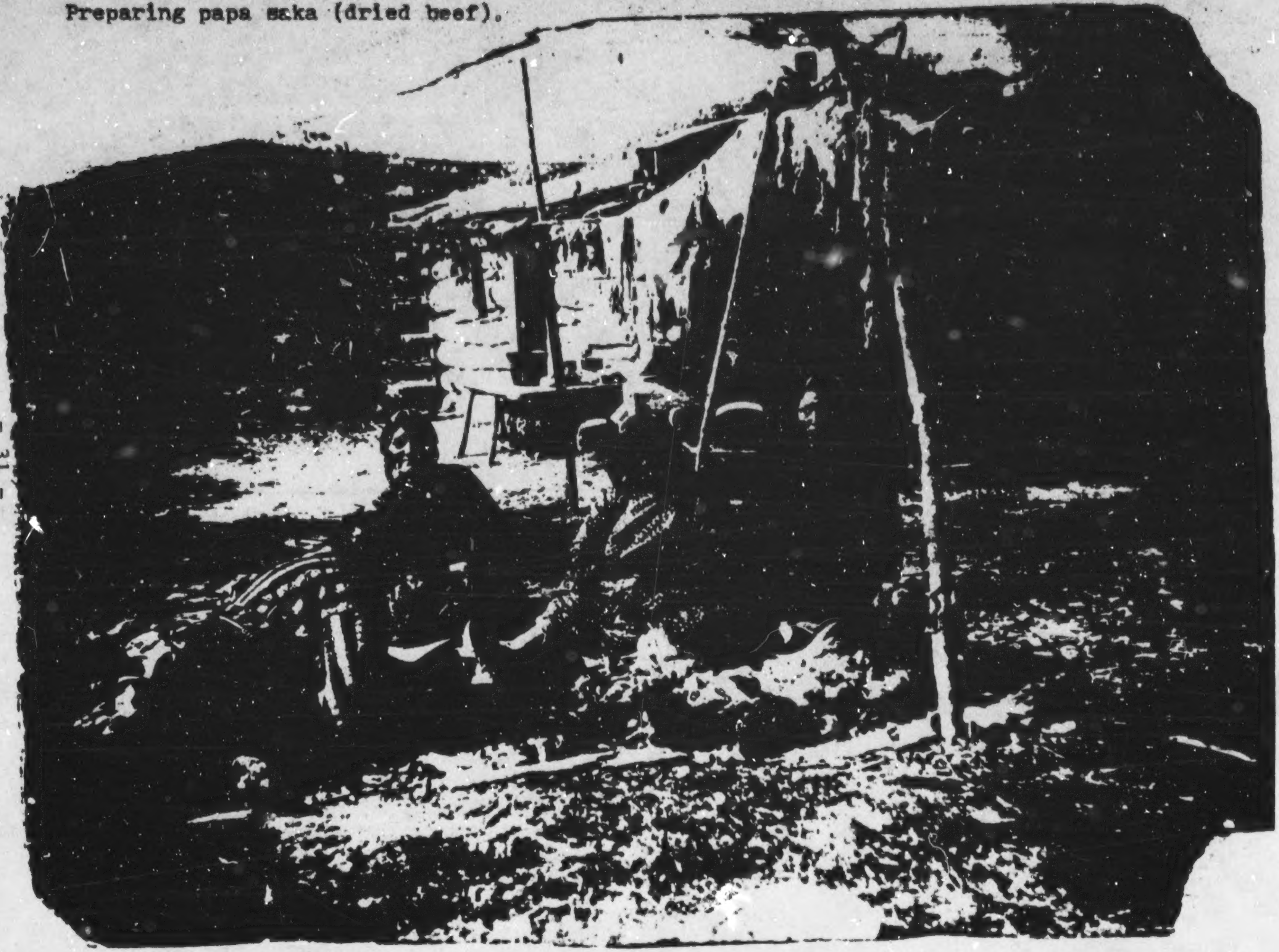
TRANSPARENCY
MASTERS

Pictures credited to
John A. Anderson Collection
Nebraska State Historical Society

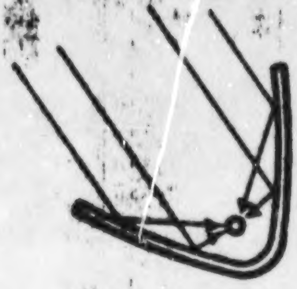
Adjust the cooker so that you can see the sun's rays cross on the focal points. How long does it take to cook a hot dog?


Put an unpainted coathanger through the focal points, then cook your hot dog on it. But be careful — it gets hot!
light rays should cross here when cooker is in focus!
Turn your hot dog so it cooks evenly!
cardboard box frame
nuts and bolts to hold the frame and solar cooker together!
curved solar cooker inside covered with aluminum foil—

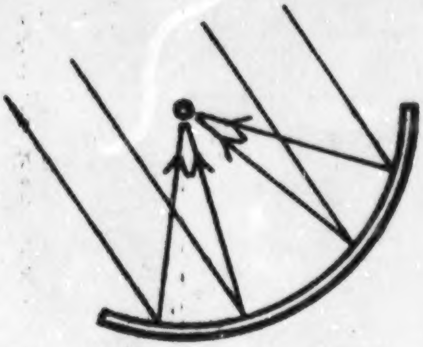
Preparing papa saka (dried beef).



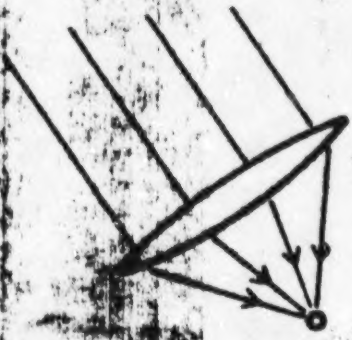
Optics is an important area of solar studies.



SHORT FOCUS REFLECTOR



LONG FOCUS REFLECTOR



FOCUSING LENS

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LABORATORY
EXERCISES

Daily motion of the sun.

The apparent path of the sun across the sky is due to the rotation of the earth, which gives us the cycles of night and day. Because this path is regular and consistent, you are able to figure the solar altitude and azimuth of the sun for any time of the year. The solar altitude is the angular height of the sun above the horizon and can be obtained with the aide of a protractor.

The solar azimuth is the distance in angular degrees in a clockwise direction from the north point or true north. A compass will be used to find the azimuth of the sun, simply by finding the true north and placement of the protractor in the angle of the sun and recording this information.

Once the solar altutude and azimuth have been found, use of the following chart will allow you to determine the amount of solar energy available. The chart is for 40° N. latutude and minor corrections may be necessary to compensate for the other regions of Nebraska.

In reading the chart for the Solar Position, first find the date or month desired. Next locate the solar time (not daylight savings time). The next column tells the amount of BTU's that can be obtained on a flat surface. The next set of charts provide the information for the angle of the surface that is exposed to the sun.

EXAMPLE:

May 21, 10:00 a.m. if the surface is at a 30° angle to the horizontal, you would receive 270 BTU's or a total possible of 2442 BTU's during any 8 hour period.

NOTE:

DO NOT LOOK DIRECTLY AT THE SUN TO DO THIS EXPERIMENT!
In trying to find the solar altutude, use a pencil or another small object placed alongside the protractor. When the shadow is just a small point take the reading from the protractor showing the desired angle of the sun.

SOLAR POSITION AND INSOLATION, 40°N LATITUDE

DATE	SOLAR TIME		SOLAR POSITION		BTUH/SQ. FT. TOTAL INSOLATION ON SURFACES						
	AM	PM	ALT	AZM	NORMAL	HORIZ.	SOUTH FACING SURFACE ANGLE WITH HORIZ.				
							30	40	50	60	90
JAN 21	8	4	8.1	55.3	142	28	65	74	81	85	84
	9	3	16.8	44.0	239	83	155	171	182	187	171
	10	2	23.8	30.9	274	127	218	237	249	254	223
	11	1	28.4	16.0	289	154	257	277	290	293	253
	12		30.0	0.0	294	164	270	291	303	306	263
	SURFACE DAILY TOTALS				2182	948	1660	1810	1906	1944	1726
FEB 21	7	5	4.8	72.7	69	10	19	21	23	24	22
	8	4	15.4	62.2	224	73	114	122	126	127	107
	9	3	25.0	50.2	274	132	195	205	209	208	167
	10	2	32.8	35.9	295	178	256	267	271	267	210
	11	1	38.1	18.9	305	206	293	306	310	304	236
	12		40.0	0.0	308	216	306	319	323	317	245
	SURFACE DAILY TOTALS				2640	1414	2060	2162	2202	2176	1730
MAR 21	7	5	11.4	80.2	171	46	55	55	54	51	35
	8	4	22.5	69.6	250	114	140	141	138	131	89
	9	3	32.8	57.3	282	173	215	217	213	202	138
	10	2	41.6	41.9	297	218	273	276	271	258	176
	11	1	47.7	22.6	305	247	310	313	307	293	200
	12		50.0	0.0	307	257	322	326	320	305	208
	SURFACE DAILY TOTALS				2916	1852	2308	2330	2284	2174	1484
APR 21	6	6	7.4	98.9	89	20	11	8	7	7	4
	7	5	18.9	89.5	206	87	77	70	61	50	12
	8	4	30.3	79.3	252	152	153	145	133	117	53
	9	3	41.3	67.2	274	207	221	213	199	179	93
	10	2	51.2	51.4	286	250	275	267	252	229	126
	11	1	58.7	29.2	292	277	308	301	285	260	147
	12		61.6	0.0	293	287	320	313	296	271	154
	SURFACE DAILY TOTALS				3092	2274	2412	2320	2168	1956	1022
MAY 21	5	7	1.9	114.7	1	0	0	0	0	0	0
	6	6	12.7	105.6	144	49	25	15	14	13	9
	7	5	24.0	96.6	216	214	89	76	60	44	13
	8	4	35.4	87.2	250	175	158	144	125	104	25
	9	3	46.8	76.0	267	227	221	206	186	160	60
	10	2	57.5	60.9	277	267	270	255	233	205	89
	11	1	66.2	37.1	283	293	301	287	264	234	108
	12		70.0	0.0	284	301	312	297	274	243	114
	SURFACE DAILY TOTCLS				3160	2552	2442	2264	2040	1760	724
JUN 21	5	7	4.2	117.3	22	4	3	3	2	2	1
	6	6	14.8	108.4	155	60	30	18	17	16	10
	7	5	26.0	99.7	216	123	92	77	59	41	14
	8	4	37.4	90.7	246	182	159	142	121	97	16
	9	3	48.8	80.2	263	233	219	202	179	151	47
	10	2	59.8	65.8	272	272	266	248	224	194	74
	11	1	69.2	41.9	277	296	296	278	253	221	92
	12		73.5	0.0	279	304	306	289	263	230	98
	SURFACE DAILY TOTALS				3180	2648	2434	2224	1974	1670	610
JUL 21	5	7	2.3	115.2	2	0	0	0	0	0	0
	6	6	13.1	106.1	138	50	26	17	15	14	9
	7	5	24.3	97.2	208	114	89	75	60	44	14
	8	4	35.8	87.8	241	174	157	142	124	102	24
	9	3	47.2	76.7	259	225	218	203	182	157	58
	10	2	57.9	61.7	269	265	266	251	229	200	86
	11	1	66.7	37.9	275	290	296	281	258	228	104
	12		70.6	0.0	276	298	307	292	269	238	111
	SURFACE DAILY TOTALS				3062	2534	2409	2230	2006	1728	702
AUG 21	6	6	7.9	99.5	81	21	12	9	8	7	5
	7	5	19.3	90.0	191	87	76	69	60	49	12
	8	4	30.7	79.9	237	150	150	141	129	113	50
	9	3	41.8	67.9	260	205	216	207	193	173	89
	10	2	51.7	52.1	272	246	267	259	244	221	120
	11	1	59.3	29.7	278	273	300	292	276	252	140
	12		62.3	0.0	280	282	311	303	287	262	147
	SURFACE DAILY TOTALS				2916	2244	2354	2258	2104	1894	978
SEP 21	7	5	11.4	80.2	149	43	51	51	49	47	32
	8	4	22.5	69.6	230	109	133	134	131	124	84
	9	3	32.8	57.3	263	167	206	208	203	193	132
	10	2	41.6	41.9	280	211	262	265	260	247	168
	11	1	47.7	22.6	287	239	298	301	295	281	192
	12		50.0	0.0	290	249	310	313	307	292	200
	SURFACE DAILY TOTALS				2708	1788	2210	2228	2182	2074	1416
OCT 21	7	5	4.5	72.3	48	7	14	15	17	17	16
	8	4	15.0	61.9	204	68	106	113	117	118	100
	9	3	24.5	49.8	257	126	185	195	200	198	160
	10	2	32.4	35.6	280	170	245	257	261	257	203
	11	1	37.6	18.7	291	199	283	295	299	294	229
	12		39.5	0.0	294	208	295	308	312	306	238
	SURFACE DAILY TOTALS				2454	1348	1962	2060	2098	2074	1654
NOV 21	8	4	8.2	55.4	136	28	63	72	78	82	81
	9	3	17.0	44.1	232	82	152	167	178	183	167
	10	2	24.0	31.0	268	126	215	233	245	249	219
	11	1	28.6	16.1	283	153	254	273	285	288	248
	12		30.2	0.0	288	163	267	287	298	301	258
	SURFACE DAILY TOTALS				2128	942	1636	1778	1870	1908	1686
DEC	8	4	5.5	53.0	89	14	39	45	50	54	56
	9	3	14.0	41.9	217	65	135	152	164	171	163
	10	2	20.7	29.4	261	107	200	221	235	242	221
	11	1	25.0	15.2	280	134	239	262	276	283	252
	12		26.6	0.0	285	143	253	275	290	296	263
	SURFACE DAILY TOTALS				1978	782	1480	1634	1740	1796	1646

SUN-PATH CHART.

Purpose: To find the hours of the day that best allow for maximum solar collection.

Materials: Protractor, pencil, rubber band and sun chart. magnetic compass.

Procedure: Place the protractor with the pencil attached by means of the rubber band on a flat surface. Sight along the pencil and record any obstacle seen, showing the angle or altitude. Upon completion of the readings, use dots to record this information on the sun chart and color in the area.

Observation: Azimuth and Altitude Readings.

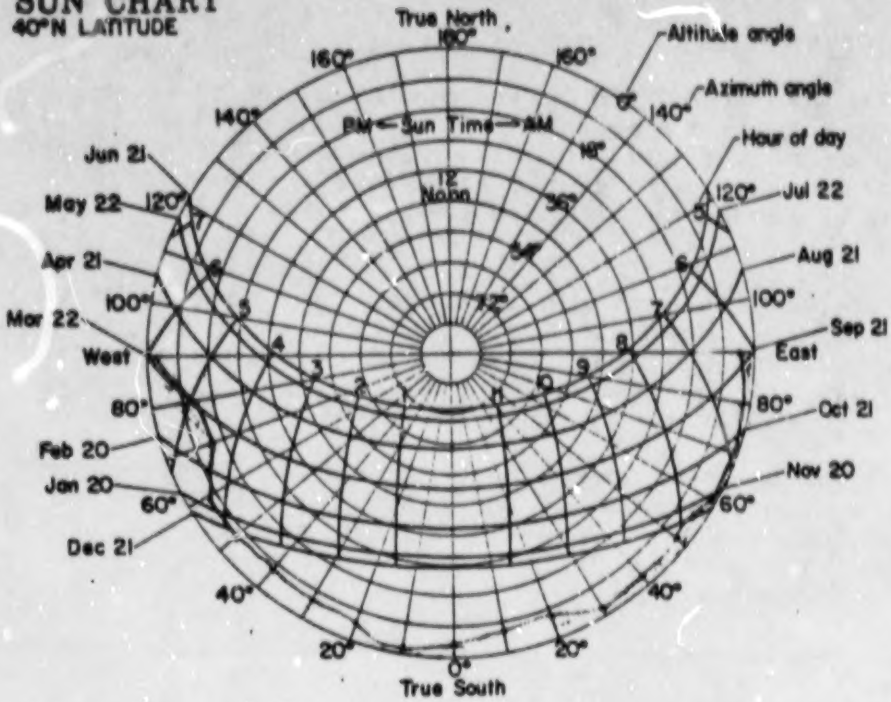
Azimuth (West)	Altitude		Azimuth (East)	Altitude	

Conclusion: From the above findings, what hours will you be able to obtain maximum solar energy?

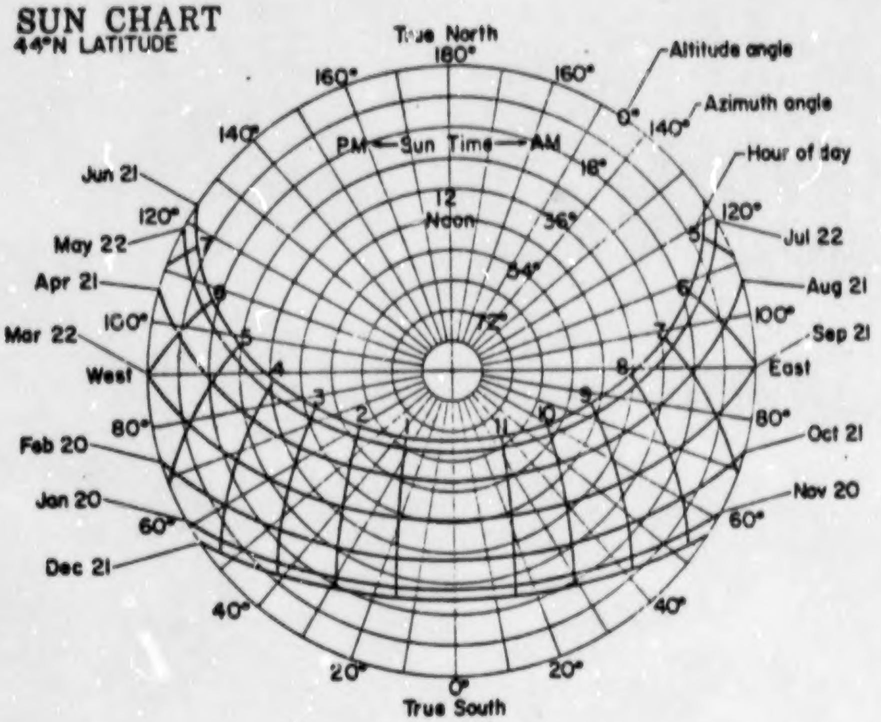
When should you start the solar collection?

What months will allow for maximum solar collection?

SUN CHART
40°N LATITUDE



SUN CHART
44°N LATITUDE



SOLAR DRYER

To make the solar dryer, obtain a box 12 inches wide, 14 inches tall and 24 inches long. Measure down three inches on the front surface and draw a line connecting the front with the back. Cut off the above surface so that the dryer is now 11 inches tall in the front and 14 inches tall in the back.

Now measure down one inch from the front and from this point, measure down two inches. When all of the points are connected, you will have an area 22 inches long and 2 inches wide that will be removed. Save the piece cut out for back support for the drying rack.

Construct the drying rack by measuring in one inch all the way around a piece of cardboard that is 20 inches long and 12 inches wide. Remove the inner portion and support the corners with masking tape. Next, cover the central open area with cheesecloth.

With the extra strip left from the outer box, construct the back support. Measure up 8 inches from the bottom of the box and glue the strip along this mark. When the drying rack or frame is placed in the box, it will now be supported.

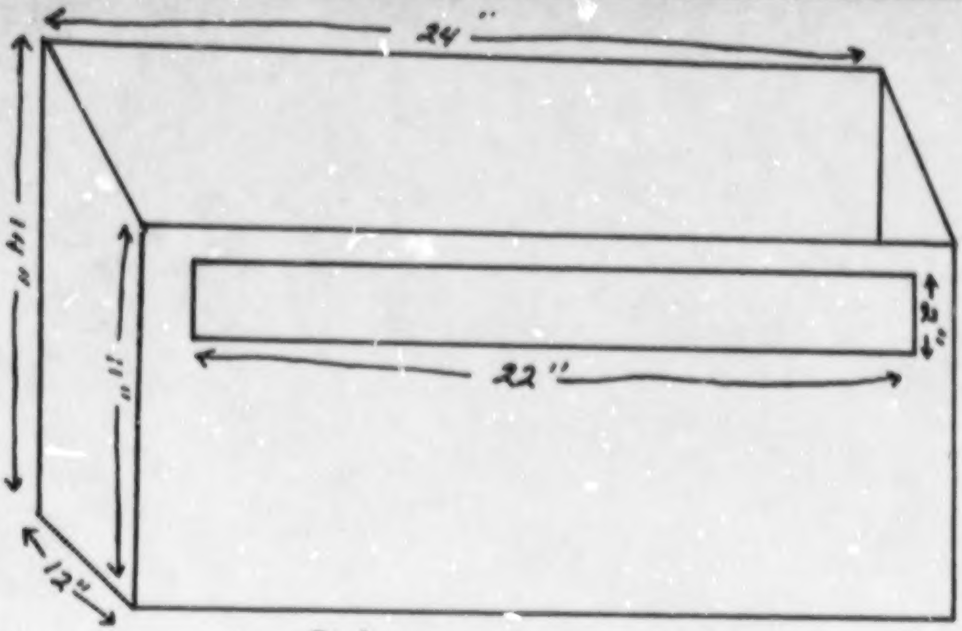
Line the inside of the box with aluminum foil, keeping the foil free from wrinkles. The foil should be glued in place. Cover the top of the box with plastic and tape it in place, (do not glue the plastic in case you have to get into the box).

The last step in construction of the dryer is to place a solid thermal mass in the bottom of the box. This can be done by using large rocks or bricks. If neither of these items are handy, paint empty pop cans black and fill with water, covering the hole with black plastic tape.

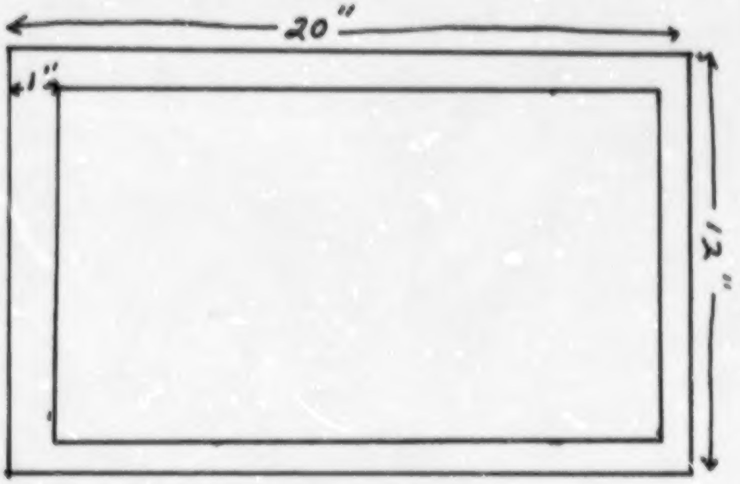
The box should then be painted black, so that all outside surfaces are covered. Stress to the students that the black surface is used as an absorbing surface of the sun's energy.

Once the dryer is complete, fruit can be dried according to the enclosed recipe. Fruit leather can also be made, however, leather may soil the cheesecloth, which must then be replaced.

Finding the correct position for the greatest amount of sun, place the dryer and fruit in the sun and allow to dry. Jerky can also be made or any other dried foods.


24"
14"
11"
2"
22"
12"

Solar Dryer



FRAME FOR cheese cloth.

Scale:
1cm = 2 inches.

Beef Jerky

Use 1½ lbs. flank steak or venison. Trim off all fat. Meat is easier to cut if semi-frozen. Slice 1/8 inch thick, cutting with the grain of the meat. Lay slices in shallow dish. Cover with marinating sauce- adding water if necessary but do not dilute too much. Cover and let stand overnight in refrigerator.

Marinating Sauce

1 t seasoned salt
1/3 t garlic powder
1/3 t black pepper
1 t monosodium glutamate
1 t onion powder
1 t liquid smoke
1/3 cup Worcestershire sauce
1/3 cup Soy sauce
Appx ½ cup water

Lay strips of marinated meat in single layer on oven rack (solar dryer). When done, Jerky should be black outside and brown inside. Makes ½ lb. of jerky.

SOLAR DRYING OF FRUIT

Apples:

Core and peel the apples before drying. Following the initial preparation, slice the applies into 1/4 inch slices and spread out over the cheese cloth. Be certain that the slices do not touch so that the air can circulate around the apples.

Pears:

Wash pears carefully and remove any stems. Cut pears in half, lenghthwise. Remove any seeds and place pears on cheesecloth, face down for drying in solar oven. Since pears have a lot of juice, drying time may take longer than apples.

Fruit Leather:

Choose the fruit to be used and wash and pare. Remove any seeds and stems from the fruit. Cut into pieces and place in blender.

Apples: Cut applies into pieces and place in blender and run until smooth. Season applies with cinnamon to taste. Usually 1 teaspoon to two apples. Spread the blended apples on the cheesecloth and place in solar dryer.

Pears: Peel pears and remove seeds, cut pears into small pieces and place in blender. Season, if desired, with small amount of honey. Spread the blended pears on the cheesecloth in the solar dryer.

Bananas: Peel bananas and cut into small pieces. Place into blender and season with small amount of honey. Spread the blended banana on the cheesecloth in the solar dryer.

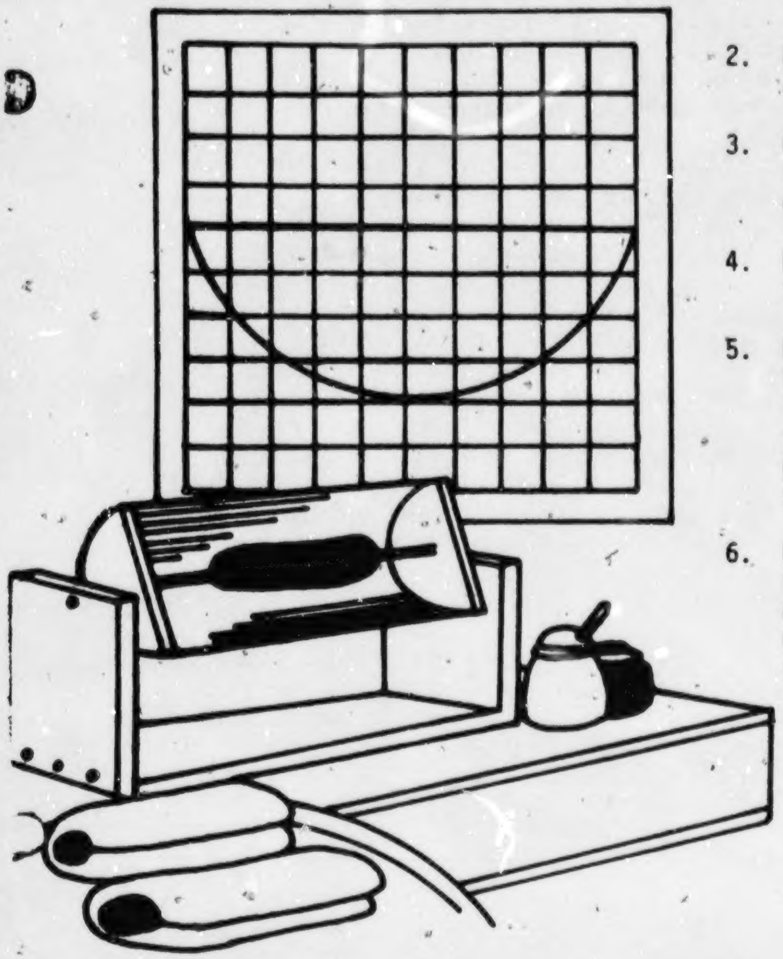
Leather Blend: Prepare an apple and banana as before. Place small pieces in the blender and season with 1/4 teaspoon cinnamon. Run blender until smooth and spread the mixture on the cheesecloth in the solar dryer.

Any mixture of favorite fruits can be prepared in this way. Experiment with seasoning and fruits to taste, some people find that vanilla is more favorable than honey with the bananas and especially with other fruits.

SOLAR HOT DOG COOKER

Experiment taken from Energy Conservation: Experiments You Can Do, Thomas Alva Edison Foundation, Inc., 1974.

Materials: piece of 1 x 8 lumber 4 ft. long, 1 ft. wide by 2 ft. long sheet of aluminum (the kind sold in hardware and lumber stores), 2 four-inch nails, handful of short nails, two wood screws about 2 inches long, two metal washers to fit the screws, pad of steel wool, tube of household cement, shiny aluminum foil, large piece of brown wrapping paper and pencil, yardstick or ruler, hot dogs, tin snips



1. Draw a grid of one-inch squares on the wrapping paper. The grid should contain 100 squares and measure 10 inches by 10 inches.
2. Draw on the grid the pattern and be ACCURATE!
3. Cut out the pattern, lay it on the piece of wood next to one end and trace it.
4. Make a second one just like the first.
5. Use a wood saw to cut out the two side pieces. Then cut a 12 1/4 inch piece of wood for the base and two 8 1/4 inch pieces of wood for the side supports.
6. Nail the piece of aluminum to the side panels to make a type of aluminum-bottomed "canoe." Cut off the excess metal with tin snips. ⇨

500

7. Use the steel wool to polish the inner surface of the aluminum and wipe off. Apply a layer of household cement to the surface and cover with a piece of aluminum foil cut to fit inside the "canoe." (shiny side out!)
8. Look at the sketch. Drill one hole in the center of the upper portion of each side panel.
9. Push the long nails into the holes and secure with a small amount of cement. Polish the nails with steel wool and rinse with water.
10. Nail the base and side supports together.
11. Drill a hole near the top of each side support.
12. Use the wood screws and washers to mount the "canoe" on the support stand.
13. Skewer a hot dog on the two long nails, point the cooker toward the sun. It takes a minute or two of strong sunlight to prepare the hot dog.
14. Use a fork to remove the hot dog as the nails get hot.

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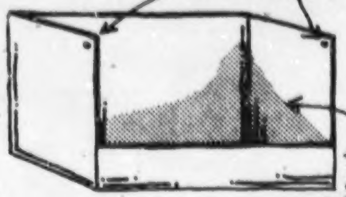
HOW LONG DOES IT TAKE TO COOK A WITH THE SUN? 4

Do this first:

MATERIALS:

- 1 Hot dog
- Cardboard boxes
- Aluminum foil
- Coathanger, thumbtack, string, pencil
- 2 Small nuts and bolts
- Rubber cement

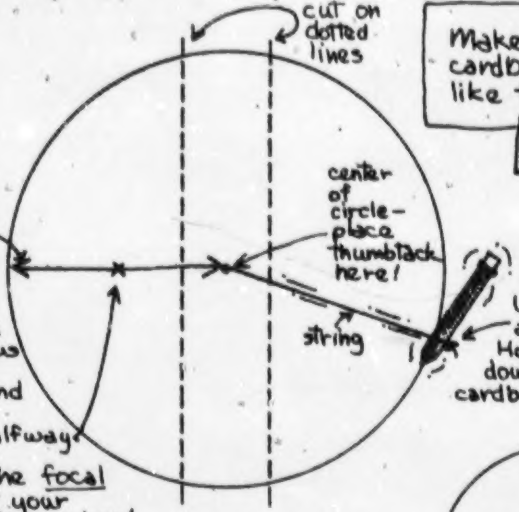


Poke holes here for nuts and bolts!

Cut the top and front out of a cardboard box to make a frame for your solar cooker!

Then, do this:

Make 2 large cardboard circles like this:

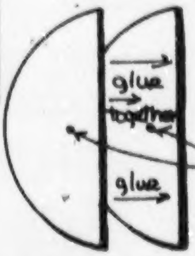


cut on dotted lines
adius
f
ircle
center of circle- place thumbtack here!
string

easure
e radius
f the
ircle, and
ake a
ark halfway

his is the focal
oint of your
solar cooker!

Use the string to hold the pencil, and attach the other end to the thumbtack. Hold the pencil tightly, straight up and down, and draw a circle on a piece of cardboard! Then, cut apart as shown.

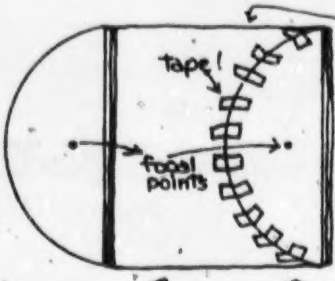


glue
together
glue
focal points!

Now, glue 2 pieces together to make 1 that's twice as heavy!

Do this with both circles you cut-

Now, put the 2 curved pieces together like this:



tape!
focal points

Tape another piece of cardboard to the curved edges of the 2 half circles you glued together-

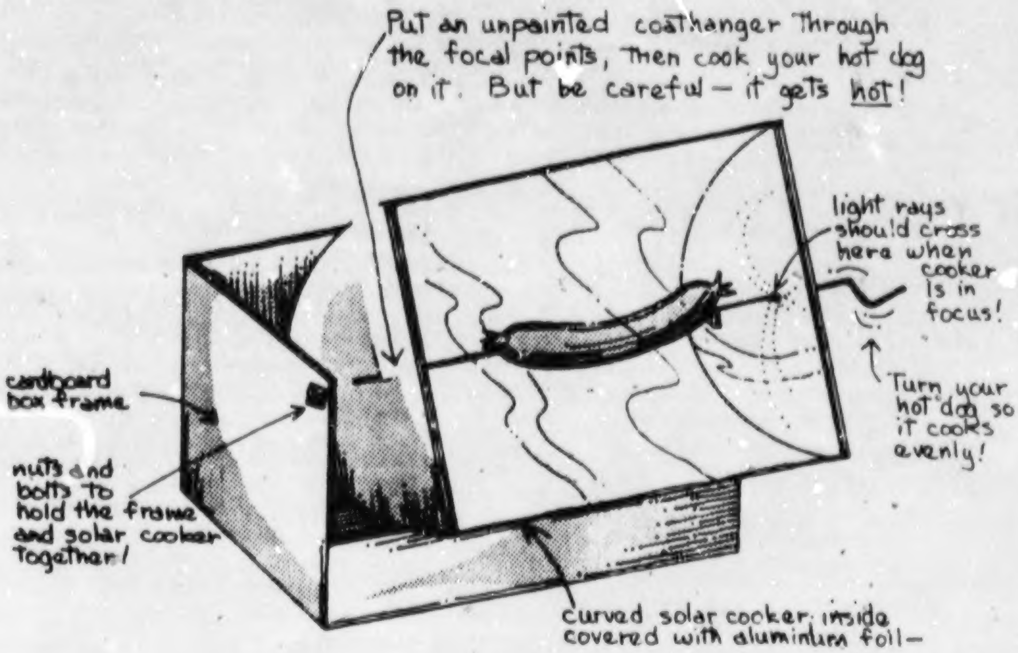
the width of the piece of cardboard should be slightly less than the width of the box you cut to make a frame!

Then, cover the inside of this piece with aluminum foil- use rubber cement!

Cover all of inside with aluminum foil!

over

Adjust the cooker so that you can see the sun's rays cross on the focal points. How long does it take to cook a hot dog?


Put an unpainted coathanger through the focal points, then cook your hot dog on it. But be careful – it gets hot!
light rays should cross here when cooker is in focus!
Turn your hot dog so it cooks evenly!
cardboard box frame
nuts and bolts to hold the frame and solar cooker together!
curved solar cooker inside covered with aluminium foil–

HOW MUCH CLEAN WATER CAN THE SUN GET OUT OF A PAN OF MUDDY WATER IN A SINGLE DAY?

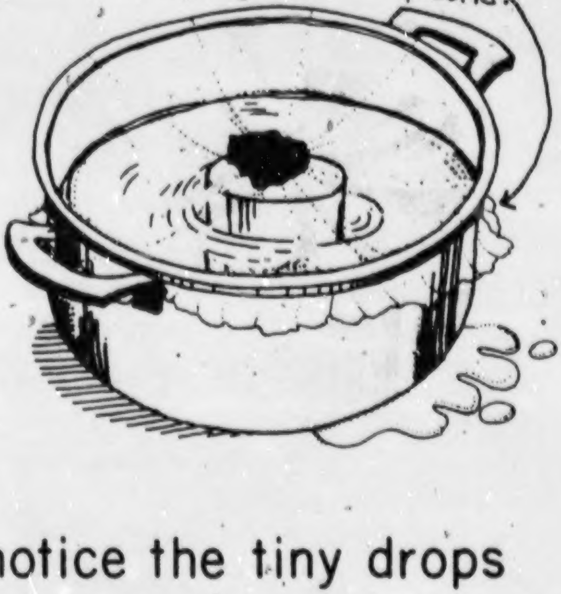
1.

MATERIALS:

- Large pan or tub
- Clear plastic food wrap
- Rock
- Masking tape
- Muddy water
- Drinking cup or glass

Fill a pan to a depth of 5 cm with muddy water.

Then, do this:



Place the drinking cup in the middle and cover the pan with clear plastic. Tape the plastic firmly!

Put a rock on the plastic wrap to make it sag in the middle, but don't let the rock touch the cup!

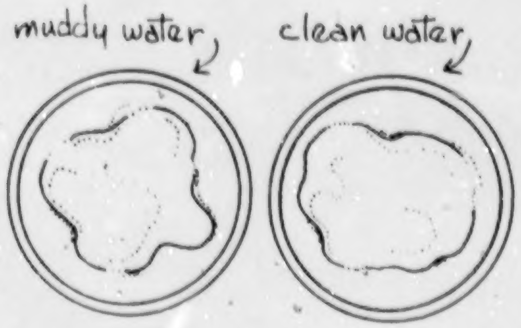
Don't let the rock touch the cup! (you may have to put a weight in the cup to keep it from floating.)

Tape holds plastic!

As the water evaporates, notice the tiny drops that condense on the cool plastic wrap.

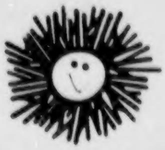
OTHER IDEAS TO EXPLORE:

Try this experiment with salty water. Do you get more clean water than from muddy water? Is this a good way for your city to get pure water to drink? From this experiment does it look like mud evaporates?

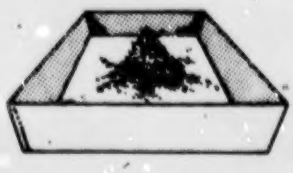


Check to see how clean your water is by placing several drops of muddy or salty water on the curved bottom of a plastic cup. Do the same with a few drops of clean water. After the water evaporates from both cups, notice if any residue is left behind.

Try making salt by evaporating seawater. In a large flat pan, pour a measured amount of seawater. Allow it to evaporate. Keep adding measured amounts until the salt forms crystals. Weigh the dry salt. How much seawater did it take?



To make seawater - add 1 teaspoon salt to 1 cup water!



COLLECTION OF FRESH WATER IN DESERT CONDITIONS

Purpose: To demonstrate an alternate method of water collection for survival.

Materials: Spoon or shovel, large rocks, clear plastic sheet.

Procedures: Dig a pit into the ground with sides sloping. Line the pit with a solid sheet of plastic and weight corners with stones, also placing a stone in the center of the plastic. Allow to stand open over night and collect the water in the morning.

Observations:

Time constructed:

Temperature at time of construction:

Time terminated:

Temperature at termination:

Amount of water collected:

Conclusion: Why is it possible to collect fresh water in this fashion?

What causes dew to form on blades of grass in the morning?

Are there any connections between the collection of the water and the dew and if so what are they?

Resources

Energy Conservation In The Home; U. S. Department of Energy, T.I.C., P.O. Box 62, Oak Ridge, Tn. 37830

Survey of Passive Solar Buildings; National Solar Heating and Cooling Information Center, P. O. Box 1607, Rockville, MD 20850

Solar Energy in America's Future; Stanford Research Institute, Superintendent of Documents, United States Government Printing Office, Washington, DC 20402

Solar Energy; William W. Eston, periodical, Energy Research and Development Administration, Office of Public Affairs, Washington, DC 20545

Solar Electricity From Photovoltaic Conversion; United States Department of Energy, Office of Public Affairs, Washington, DC 20585

Solar Energy for Heating and Cooling; U.S. Department of Energy, Office of Public Affairs, Washington, DC 20585

I've Got a Question About Using Solar Energy; U.S. Department of Energy, Office of Public Affairs, Washington, DC 20585

Solar '77'; Gene Wenzel, booklet, U.S. Department of Energy, Office of Public Affairs, Washington, DC 20585, 1978

Nebraska Pioneer Cookbook; Day Graber, University of Nebraska Press, Lincoln, NE 1974

Videa Tapes and Slides

Dawn Of The Solar Age; NOVA, Solar Energy Video Tape. Nebraska Educational T.V., Lincoln, Nebraska. Also available from UNL, Center for Economic Education, Dr. William Gillies

Slides, The Solar-ed Corp., Woodbridge, Conn. 200 slides for $129.95

Sunshine Kids; Crystal Productions, Aspen, Colorado. Filmed at Carbondale, Colorado showing applied Solar Energy by the students at the Colorado Rocky Mountain School in the design and building of a solar greenhouse.

SUPPLEMENT

Nebraska State Energy Office
4th Floor, 301 South Centennial Mall
P.O. Box 95085
Lincoln, Nebraska 68509

Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

Dr. Ronald Shore
Thermal Technology Corporation
Basalt, Colorado

Mirror for Man: The Relation of Anthropology to Modern Life:
Kluckhohn, Clyde. New York: Whittesey, 1949

Ford Foundation Energy Policy Project, *A Time to Choose:*
Cambridge, Mass., Ballinjer Publishing Company, 1974.

CREDITS

Pictures pertaining to Indian culture, Nebraska State Historical Society.

Lab materials, U.S. Department of Energy.

Solar Charts, Thermal Technology Corporation.

Recipes from Judith Williams, Carolyn Cook and Lanna Tetjen